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Long Term Production Outlook for the Canadian Aquaculture Industry (1990 Edition)

Economic and Commercial Analysis
Report No. 67

Fisheries and Oceans Pêches et Océans

Canada

Long Term Production Outlook For The Canadian Aquaculture Industry

(1990 Edition)

Commercial and Market Analysis Division

Economic and Commercial Analysis Directorate
Department of Fisheries and Oceans
Ottawa, Ontario
K1A 0E6

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ABSTRACT

Canada's aquaculture industry has seen rapid and exciting growth over the last decade. It is young and dynamic, and shows considerable potential for future growth.

This report was prepared by Price Waterhouse Management Consultants and is an update of their 1988 report on the same subject. This report (as well as the original report) was commissioned by the Economic and Commercial Analysis Directorate of the Department of Fisheries and Oceans to assess the growth potential of the Canadian aquaculture industry to the year 2000 considering all of the recent industry changes. The main purpose of these reports has been to present a systematic projection of growth potential in order to assist in the development of a federal aquaculture strategy.

The report contains three growth scenarios for each of the major species groups now produced commercially in Canada: salmon, trout, oysters and mussels. In addition prospects for farming arctic char and scallops are discussed.

The views and opinions expressed in the report are those of the consultant and do not necessarily reflect the views of the Federal Department of Fisheries and Oceans.

RÉSUMÉ

Au cours de la dernière décennie, l'industrie aquicole canadienne a connu une croissance rapide et stimulante. Jeune et dynamique, elle a un avenir des plus prometteurs.

Ce rapport a été préparé par Price Waterhouse Management Consultants et constitue la mise à jour de son rapport de 1988 sur le même sujet. Le présent rapport (ainsi que son prédécesseur) a été commandé par la Direction générale de l'analyse économique et commerciale du ministère des Pêches et des Océans pour évaleur les possibilités de croissance de l'industrie canadienne de l'aquiculture jusqu'à l'an 2000, compte tenu de tous les changements qui y sont survenus dernièrement. Ces rapports cherchent surtout à présenter une projection systématique des possibilités de croissance pour contribuer ainsi à l'élaboration d'une stratégie fédérale sur l'aquiculture.

Le rapport expose trois scénarios de croissance pour chacun des principaux groupes d'espèces actuellement élevées commercialement au Canada: le saumon, la truite, les huîtres et les moules. Il présente en outre des perspectives concernant l'élevage de l'omble-chevalier et du pétoncle.

Les vues et les opinions exprimées dans le rapport sont celles du consultant et ne traduisent pas nécessairement celles du ministère fédéral des Pêches et des Océans.

Department of Fisheries and Oceans

Long Term Production Outlook for the Canadian Aquaculture Industry

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Department of Fisheries and Oceans

Long Term Production Outlook for the Canadian Aquaculture Industry

Executive Summary

The Federal Department of Fisheries and Oceans commissioned Price Waterhouse to assess the growth potential of the Canadian aquaculture industry to the year 2000. The report was issued originally in January, 1989. The updated version was produced in July 1990. The major species considered include farmed salmon, oysters, mussels, trout, arctic char and scallops.

Making long term projections is a challenging task when an industry is relatively young and still growing at a very high rate, particularly for certain industry sectors. For this reason, three scenarios have been developed for salmon, oysters, mussels and trout: high, medium and low growth. The underlying assumptions for each scenario are spelled out in the text to enable the reader to evaluate the projections. Projections have not been established for arctic char or scallops because of the relative youth of these sectors.

Two assumptions form the basis of the analysis in this report:

- A narrow definition of the aquaculture industry has been used: only grow-out sites have been considered in the analysis. This does not take into account substantial backward and forward linkages to hatcheries, processing plants, feed and equipment suppliers which from an integral part of the aquaculture sector. This report therefore underestimates, to some extent, true levels of activity and employment attributable to aquaculture.

- Employment has been estimated on the basis of full-time equivalent positions. The methodology for estimating the number of positions by species is described in the footnote to table 2. The estimates derived using this methodology provide useful indicators as to levels of employment in the industry. However, actual levels of employment will be underestimated. Substantially more people, employed either full-time or part-time, will earn a living from the aquaculture industry than are indicated by the figures produced in this report.

In conducting this work we have relied on publicly available data, input from Canadian Aquaculture Producer's Council members, and information provided by numerous industry and government officials. The work was conducted over a limited time and budget and aims to provide an indication of the expected performance of the aquaculture sector. However, further in-depth investigations, which broaden the definition of the aquaculture industry and which assess both direct and indirect employment, should be carried out before investments are made on the basis of these projections. Furthermore, the scenarios developed in this report represent the views of the authors based on the

information available at the time of writing. These projections do not necessary reflect the views of the Department of Fisheries and Oceans or any other individuals and organizations contacted in the process of conducting the study.

The results of our analysis are summarized below and are presented in detail in the report. The enclosed report presents a detailed review of the analysis.

The Salmon Farming Industry in British Columbia

- The B.C. salmon farming industry has grown from four commercial farms in 1981 to 135 operating farm sites in 1989 and an estimated 120 sites in 1990. The number of operating sites is expected to decline in 1990 due to several receiverships (approximately 21 to April 1990). Rationalization in the industry was expected after a period of staggering growth. While we may see a further decline in corporate entities in the short term due to mergers and acquisitions and receiverships, the number of operating sites in B.C. is not expected to continue its decline.

- 1989 production was approximately 12,400 MT, compared to 6,590 MT in 1988 and an estimated 15,000 in 1990. In contrast, there was a commercial salmon catch of about 84,823 MT in 1988.

- Though it has developed very rapidly in recent years, salmon farming in B.C. is still in a developmental stage when compared to salmon farming in Norway. In 1989, farmed salmon production for Norway was 117,000 MT, as compared to about 100 MT in 1971. Other countries which are becoming important producers of farmed salmon include Scotland, Japan and Chile which grew by 62%, 82% and 56% respectively from 1988 to 1989.

- The B.C. industry may duplicate at least partly the high growth experienced in Norway over the last decade. The industry is likely to produce between 20,000 MT and 30,000 MT by 1995 and between 30,000 MT and 60,000 MT by the year 2000. Even if a high growth path is achieved, B.C. production is unlikely to match the existing Norwegian production of 117,000 MT by the year 2000 because of increasing competition from other countries and constraints facing the industry.

- For the production of B.C. farmed salmon to reach 60,000 MT by the year 2000:
  - industry will have to demonstrate profitability;
  - industry will have to become more marketing oriented;
  - prices will have to improve from 1989 levels so as to stimulate further investment in the industry. (World supplies of salmon and particularly farmed salmon are expected to rise significantly in the next decade but demand for fresh fish is also expected to increase.);
  - salmon farms will have to contain production costs, reduce mortality rates and improve rearing densities; and
  - new entrants will have to obtain sufficient operating capital during the early years of development.

- Under a low growth scenario, B.C. farmed salmon production will grow slowly for the next five years to about 20,000 MT and then plateau at 30,000 MT primarily because of international competition. Prices may remain at 1989 levels, adjusted only for inflation and the industry may experience ongoing production problems and lack of available financing.

- The major constraints facing the B.C. industry are:
  - product marketing in the face of increasing world competition;
  - production problems caused by blooms, diseases and other biophysical factors;
  - shortages of financing;
  - developmental problems requiring further research and development; and
  - opposition from other interest groups.

- The B.C. industry is characterised by a number of important strengths:
  - B.C. is close to the U.S., an important market for salmon;
  - production costs are relatively low;
  - the coastline of B.C. hosts an unlimited supply of high quality sites;
  - a well-trained workforce and substantial pool of research scientists support the industry; and
  - government regulations are comparable to those in Norway and Scotland.

The Salmon Farming Industry in Eastern Canada

- The salmon farming industry in Eastern Canada is concentrated in the Bay of Fundy in New Brunswick, where approximately 49 salmon farms are currently operating. Together these farms have a combined estimated capacity of 8,500 MT and they produced approximately 4,250 MT of salmon in 1989.

- In Nova Scotia, there are 18 operating marine sites: five large-scale operations and 13 pilot projects. Of these 18 sites, eight grow a combination of marine rainbow trout and salmon and the other ten grow only marine trout. Production excluding marine rainbow trout was 145 MT in 1989 compared to 27 MT in 1988.

- Salmon farming in Quebec and P.E.I. is limited to land based facilities because of severe winter water temperatures and ice. There are two such facilities in operation, one in each province. The facility in P.E.I. has been plagued with financial and operating difficulties and it is in receivership for the second time in about two years.

- Salmon aquaculture in Newfoundland is at an experimental stage. The industry suffered a major setback in 1988 when the existing stock of farmed salmon, smolts, and market fish was destroyed because of infection. There is one hatchery in operation in Newfoundland and salmon smolts are expected to be transferred to sea cages later this year for production in 1991.

- In Eastern Canada, New Brunswick shows the most potential for growth, followed by Nova Scotia, and the other three provinces. By 1995, the five provinces are expected to produce between 7,600 MT and 12,000 MT of farmed salmon and by the year 2000, production will likely reach between 9,000 MT and 15,500 MT of farmed salmon. Major assumptions underlying in these projections are as follows:
  - the current technology of net pens operating in sea water will continue to be the most prevalent technology used in salmon farming. Technological changes and the adoption of land based and other systems could result in higher than projected growth. Land-based systems are technically feasible, but their commercial viability has yet to be established;
  - the number of sites available in New Brunswick will be between 45 and 75 sites, which translates to a production capacity of about 13,000 MT;
  - by the year 2000, the industry in Nova Scotia is expected to produce between 500 and 2,000 MT depending on their ability to rear salmon competitively; and,
  - by the year 2,000, the industry in P.E.I., Newfoundland and Quebec is expected to produce between 500 MT and 1,500 MT depending on the ability of land-based facilities to be competitive. Moreover, attempts to grow smolts and salmon in Newfoundland may continue to be hampered by disease and other operating problems.

- The major constraints facing the industry are:
  - site availability in some Eastern provinces;
  - product marketing;
  - production problems caused by disease;
  - insufficiency of available financing;
  - opposition from other interest groups including the environmental lobby, property owners and other users of waterways; and
  - low quality smolt production in some provinces.

- Eastern Canada is also characterized by a number of strengths:
  - the area is close to the U.S., an important market for fresh salmon;
  - the industry has relatively low production costs as a result of the existing industrial suppliers, and competitive labour costs;
  - the industry is supported by a well-trained labour force and pool of research scientists with extensive experience; and
  - government regulations are conducive to growth.

The Oyster Industry in B.C.

- Commercial oyster production began in B.C. in early 1950's. It rose to a peak of 5,900 MT in 1963 but then declined due to poor growing techniques and reliance on natural oyster seed.

- Since 1981 when production was 1,415 MT, an all-time low, production quantities have increased by 38% to reach 3,900 MT in 1989.

- While B.C. waters could produce 10 to 50 times the current quantity of oysters, the industry is likely to produce between 5,000 and 7,000 MT by 1995 and 6,000 MT to 12,000 MT by the year 2000.

- The major constraints facing the oyster industry are:
  - a shortage of suitable grow-out sites;
  - insufficient supplies of suitable wild and hatchery seed;
  - relatively high labour costs, in part caused by the labour intensiveness of oyster cultivation;
  - the risk of pollution and disease;
  - internal financing and cash flow; and
  - product marketing in competitive markets.

- The oyster industry in B.C. has some important strengths:
  - increasing market demand for shellfish;
  - the potential to increase domestic markets; and
  - development of a strong marketing strategy to promote future growth.

The Oyster Industry in Eastern Canada

- 1989 oyster production in the Atlantic provinces was approximately 2,400 MT and because of water temperatures and other conditions, is limited primarily to New Brunswick (426 MT), Nova Scotia (101 MT) and P.E.I. (1,895 MT). The industry is virtually non-existent in Newfoundland and is just starting to develop in Quebec.

- There is significant potential to increase oyster production in Atlantic Canada and production is likely to reach between 3,000 MT and 5,000 MT by 1995 and between 4,000 MT and 7,000 MT by the year 2000.

- The achievement of these production levels will be largely dependent on markets and the ability of Canadian producers to remain competitive with U.S. producers. Factors which could hinder growth of the industry include:
  - the need to develop markets;
  - the ability of producers to remain competitive relative to U.S. producers; and
  - the large financing requirements due to European and American oysters taking a number of years to reach market size and given current high interest rates.

- Major constraints facing the oyster industry in Eastern Canada include:
  - weak markets;
  - reduced site availability in some areas and concentration of most sites in several regions of Eastern Canada;
  - limited seed supply;
  - insufficient financing and cash flow problems;
  - the extended life cycle of the Belon oyster; and
  - insufficient research and development in recent years.

- The oyster industry in Eastern Canada has the following strengths:
  - proximity to U.S. markets with strong demand for Canadian oysters;
  - the potential for increased market demand in both the U.S. and in Canada; and
  - potential for effective marketing campaigns.

The Blue Mussel Industry

- Mussel production in Canada was approximately 2,047 MT in 1988 with P.E.I. accounting for about 70% of this production, (1,441 MT). By 1989, P.E.I. production had risen by 86% to 2,682 MT.

- Industry production in Atlantic Canada is likely to range between 3,500 MT and 5,000 MT by 1995 and between 4,300 and 7,000 MT by the year 2000. The potential for mussel production to continue to grow will depend on the industry's ability to develop markets and maintain prices at or above the current level. Even if the number of sites in P.E.I. and the production capacity of that province prove to be limited, there are enough sites in the other Atlantic provinces to allow the industry to develop provided that markets exist.

- The industry in Eastern Canada faces certain constraints:
  - shortages of financing;
  - relatively high production costs;
  - shortages of suitable grow-out sites;
  - possibility of exceeding the carrying capacity of estuaries;
  - relatively lengthy grow-out cycle; and
  - risks of pollution and contamination.

- Eastern Canada also has cultivation advantages;
  - an abundance of natural seed supply;
  - production of a high quality product; and
  - government regulations conducive to development of the industry.

- The situation in B.C. differs from that in Eastern Canada. The blue mussel grows well throughout the province although commercial ventures have not proved feasible primarily because of:
  - severe diving duck predation;
  - unexplained pre-harvest mortalities; and
  - high incidence of fouling by a variety of organisms including barnacles and tunicates which add to the weight of the lines and require additional floatation.

  Depending on B.C.'s ability to control these problems cost effectively, the mussel industry in B.C. will either remain at an infancy stage, and continue to produce insignificant amounts through to the year 2000, or it will begin to operate on a commercial basis which could bring production to about 200 MT by the year 2000.

Trout Farming

- The production of farmed trout for human consumption started on a commercial basis about 30 years ago in Ontario. Trout farming in Canada is carried out primarily in fresh water. However, with the growth of marine culture, producers have been rearing marine trout in sea cages, primarily in Nova Scotia.

- Freshwater trout production in Canada for 1989 was approximately 2,500 MT, about 80% of which is from Ontario. This compares with annual production figures of 32,000 MT in Italy, 30,000 in Denmark, 22,000 in the U.S. and 20,000 MT in France. Japan produces between 15,000 and 20,000 MT per year.

- The industry is likely to produce between 3,400 MT and 5,200 MT of freshwater trout by 1995 and between 4,100 MT and 7,300 MT by the year 2000. Production of marine trout is likely to range between 3,500 MT and 8,500 MT by the year 2000, up from about 600 MT in 1989.

- A key challenge facing the freshwater and marine trout industries will be to develop markets in an environment which has become increasingly competitive. The ability to remain competitive will be a challenge to industry. The freshwater trout farming sector yields only modest returns to owner operators and investors. Throughout Canada, freshwater trout farming presents an alternate source of income to traditional farming and it is likely to grow over the next decade.

- Major constraints facing the Canadian trout industry include:
  - market competition both domestically and internationally;
  - relatively high production costs causing reduced profitability;
  - financing and cash flow; and
  - limited access to high quality grow-out sites.

- The strengths of the industry are:
  - proximity to a large domestic and U.S. market;
  - a well-established infrastructure and network of experts;
  - ready availability of fingerlings; and
  - the production of a high quality product.

The Arctic Char Farming Industry

- Research and development into Arctic char farming began in 1978. To date, cultivation is still in its early stages though commercial production has already begun. Current production of Arctic char is estimated to be approximately 7 MT.

- It is expected that production of char will increase over the next few years. One producer, nearing commercial production expects an output of 24 MT by the end of 1990.

- Constraints facing the industry include:
  - inadequate supplies of broodstock;
  - insufficient refinement of techniques for rearing char;
  - size variability of the end product;
  - lack of research into appropriate feed mixtures;
  - relatively long grow-out period; and
  - lack of market recognition for the fish.

- The industry does have important strengths;
  - char is a premium food fish;
  - relative ease of culture;
  - suitability of char for cold waters; and
  - strong market demand and potential for increased demand.

Scallop Farming

- The development of a scallop industry began in the late 1960's. To-date, some 20 research and commercial facilities have been established though commercial production remains at about 20 MT, with a market value of $210,000.

- It is expected that the industry, as a whole will remain in a research and development phase until 1995. However, significant technical advances are being made in the cultivation of scallops and, with test-marketing beginning in some areas, it is reasonable to expect that the industry will become commercially viable by the year 2000.

- Constraints currently facing the scallop industry include:
  - full economic viability has not yet been established;
  - no stable seed supply network exists for bay scallops;
  - the size of the end product is limited by restrictions on the length of the season;
  - limitations in genetic strains;
  - market competition;
  - risk of disease; and
  - the need for more extensive marketing research.

- The industry also has important strengths;
  - scallops are a premium product;
  - they have a short grow-out phase;
  - data on cultivation techniques is readily available and comprehensive;
  - the stability of farmed scallop supply as compared to fluctuating wild harvests;
  - the availability of suitable grow-out sites; and
  - lack of conflict between scallop cultivation and that of oysters and mussels.

Conclusion

The aquaculture industry in Canada is here to stay. In 1989, the salmon, oyster, mussel and trout farming sectors employed almost 1,900 direct full-time equivalent positions, excluding employment in hatcheries and industries supplying the industry. In 1989, employment increased by about 140 full-time equivalent positions from 1988 levels in Eastern Canada but remained about the same in British Columbia.

The industry is young and dynamic and the potential for growth is substantial. By the year 1995, the cultivation of salmon, oysters, mussels and trout is likely to create between 2,200 and 3,200 full-time equivalent positions. By the year 2000, this number is expected to range between 2,600 and 4,900. The number of people involved in the industry, however, will likely be at least two times larger as the industry involves seasonal employment and the culture of some of the species like mussels and trout is often done in combination with farming and other activities.

A summary of the employment and production projections are presented in Tables 1 and 2.

We would like to thank the Department of Fisheries and Oceans, the Canadian Aquaculture Producer's Council, and the many individuals who participated in this study for their time and co-operation.

Price Waterhouse
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Vancouver, B.C.
July 1990

TABLE 1

Summary of Outlook

Production Projections
(metric tonnes)

	Salmon			Oysters		
	1989	**1995**	**2000**	**1989**	**1995**	**2000**
B.C.	12,400	20,000-30,000	30,000-60,000	3,900	5,000- 7,000	6,000-12,000
Atlantic Canada	4,250	7,600-12,000	9,000-15,500	2,400	3,000- 5,000	4,000- 7,000
Total	16,650	27,600-42,000	39,000-75,500	6,300	8,000-12,000	10,000-19,000

	Mussels			Marine Trout[1]		
	1989	**1995**	**2000**	**1989**	**1995**	**2000**
B.C.	-	-	5- 200	300	1,000-3,000	2,000-5,000
Atlantic Canada	3,000	3,500-5,000	4,300-7,000	300	1,000-2,000	1,500-3,500
Total	3,000	3,500-5,000	4,305-7,200	600	2,000-5,000	3,500-8,500

	Freshwater Trout		
	1989	**1995**	**2000**
B.C.	125*	150- 300	200- 600
Atlantic Canada	150*	150- 200	200- 300
Ontario	1,925	2,500-3,500	3,000-4,500
Quebec	260	500-1,000	600-1,500
Prairies and Territories	100	100- 200	100- 400
Total	2,560	3,400-5,200	4,100-7,300

Note:

* estimated based on 1988.

The figures presented here are based upon publicly available data and discussions with industry experts. In some cases, the estimates tend to be slightly conservative and it is acknowledged that, should optimum conditions prevail, production in some sectors will grow at a faster rate than is predicted in a low growth scenario. In some cases, low growth projections for 1995 could be achieved much earlier.

TABLE 2

Summary of Outlook

Employment Projections
(full-time equivalent positions)

	Salmon			Oysters		
	1989	**1995**	**2000**	**1989**	**1995**	**2000**
B.C.	800	950-1,000	1,050-1,800	225	250-350	300- 600
Atlantic Can./Que.	300	315- 540	315- 600	120	150-250	200- 350
Total	1,100	1,265-1,540	1,365-2,400	345	400-600	500- 950

	Mussels			Marine Trout		
	1989	**1995**	**2000**	**1989**	**1995**	**2000**
B.C.	-	-	0- 20	10	40-110	75-185
Atlantic Can./Que.	200	230-330	280-450	20	40- 75	55-130
Total	200	230-330	280-470	30	80-185	130-315

	Freshwater Trout			Total		
	1989	**1995**	**2000**	**1989**	**1995**	**2000**
B.C.	10	10- 25	15- 50	1,045	1,250-1,485	1,440-2,655
Atlantic Can./Que.	30	50-95	65-150	670	785-1,290	915-1,680
Ontario	160	200-290	250-375	160	200- 290	250- 375
Prairies & Territories	10	10- 15	10- 30	10	10- 15	10- 30
Total	210	270-425	340-605	1,885	2,245-3,080	2,615-4,740

Note:

Data represent employment in terms of full-time equivalent jobs. The assumptions upon which these estimates have been based are shown below, by species:

Salmon:

B.C.	Five full-time equivalent positions per site: based on existing average employment figures.
New Brunswick	Six full-time equivalent positions per site: based on existing employment levels and observations of the increased capacity of farms in New Brunswick.
Quebec/Newfoundland	Ten full-time equivalent positions per site: increased labour intensity caused by land-based systems used in these provinces.

Oysters:

B.C.	20 MT/person year equivalent or five full-time equivalent positions per site: based on existing employment levels.
Eastern Canada	20 MT/person year equivalent or five full-time equivalent positions per site: B.C. methodology used as no data were available on average numbers of employees per operating site.

Mussels:

All Canada — 15 MT per full-time equivalent positions: based on the following assumptions:

- labour cost component of production is 40% of wholesale value;
- wholesale price of $1/lb.;
- average labour cost of $8/hour; and
- average number of hours worked per full-time equivalent position - 1,500 hours.

Freshwater Trout:

All Canada — 12 MT per full-time equivalent positions: based on the following assumptions:

- labour cost component of production is $1/kg.;
- average labour cost of $8/hour; and
- average number of hours worked per full-time equivalent position - 1,500 hours.

Marine Trout:

All Canada — 27 MT per full-time equivalent position: based on the assumption that marine trout farms are more capital intensive then freshwater trout farms.

It is acknowledged that, if a broader definition of employment is used, employment estimates for the industry could be two or three times those presented here.

Introduction

In November 1988, the Federal Department of Fisheries and Oceans commissioned Price Waterhouse to assess the outlook for the Canadian aquaculture industry to the year 2000. In May, 1990 the firm completed an update of this report. The major species considered include salmon, oysters, mussels, and trout.

Making long term projections is a challenging task, particularly when an industry is relatively young and still growing at a very high rate. For this reason, three scenarios were developed for each major specie, namely, high, medium and low growth. The underlying assumptions for each scenario are spelled out in the text to allow readers to form their own opinion on the projections.

In conducting this work we relied on publicly available data as well as information provided by various industry and government officials. The work was conducted over a limited time and budget and further in-depth investigations should be carried out before anyone decides to invest on the basis of these projections. Furthermore, the scenarios developed in this report represent the views of the authors based on the information available up to early April 1990. These projections do not necessarily reflect the views of the Department of Fisheries and Oceans or any other individuals and organizations contacted in the process of conducting the study.

The results of our analysis are summarized in the enclosed report in eight chapters, as outlined below:

- The Salmon Farming Industry in B.C.
- The Salmon Farming Industry in Eastern Canada
- The Oyster Industry in B.C.
- The Oyster Industry in Eastern Canada
- The Blue Mussel Farming Industry
- Trout Farming
- The Arctic Char Farming Industry
- Scallop Farming

Each chapter reviews the historical development of the industry, describes the constraints and the strengths of Canadian aquaculture producers and presents an outlook to the year 2000 for each of the major species.

Chapter 1 - The Salmon Farming Industry in B.C.

Historical Development of Salmon Farming in B.C.

The first commercial salmon farm license was issued in British Columbia in 1972. However, throughout the 1970's and early 1980's, there were only a handful of farms operating in B.C. During that time, the industry suffered a number of setbacks including:

- low survival rates;
- lower than expected growth rates;
- lower than expected profitability, particularly as farms focused on the pansize market which proved to be less profitable than the larger size fish market; and
- under capitalization and difficulty in obtaining financing, a fact which partly resulted in the collapse of B.C.'s largest aquaculture firm, Apex Bio Resources Limited, in January 1982.

Beginning in 1984, the industry witnessed a surge in the number of operating farms and applications for operating licenses. However, in 1989, there was a decrease in the number of salmon farming companies due to a number of receiverships (approximately 21 to April 1990). Rationalization in the industry was expected after a period of rapid growth. Although we may see a further decline in operating corporations in the short term due to mergers and acquisitions and possibly more receiverships, the number of operating sites is not expected to decrease materially. The number of operating sites in B.C. for the years 1981 through 1990 is presented in Table 3.

TABLE 3

B.C. Salmon Farming Industry

	Number of Operating Sites[1]	Production	
		Volume (metric tonnes)	Value ($000's)
1979	N/A	41	157
1980	N/A	157	898
1981	4	176	985
1982	5	273	1,136
1983	8	128 [2]	708
1984	10	107	702
1985	37	120	820
1986	69	397	2,900
1987	118	1,362	10,280
1988	150	6,590	39,080
1989	135	12,400	75,000
1990*	120 [3]	15,000	90,000

* estimated

Notes:

[1] Licensed operations with fish in the water.

[2] The largest producer ceased production in 1982, resulting in a production decline in 1983.

[3] 68 companies operating in early April 1990.

Source: Department of Fisheries and Oceans, Canada
B.C. Ministry of Agriculture and Fisheries
B.C. Salmon Farmers Association
Discussions with industry

As shown by Table 3, there were an estimated 135 operating salmon farm sites in 1989, up from only ten in 1984. As of January 1990 there were 213 approved salmon farm tenures (203 licences and ten leases), 33 investigative permits issued, and 60 new applications and amendments of development plans being reviewed by the B.C. Ministry of Agriculture and Fisheries.

Table 3 also shows farmed salmon production in B.C. over the last decade. Farmed salmon production in B.C. remained between 100 and 300 MT per year throughout the early 1980's. It then started to increase significantly in 1987 and 1988 when it reached 1,362 MT and 6,590 MT, respectively. In 1989, B.C. farmed salmon production was approximately 12,400 MT.

The actual farm holding capacity is estimated (based on 135 operating farms and an average farm capacity of 200 MT) at about 27,000 MT as estimated by the B.C. Ministry of Agriculture and Fisheries (theoretical holding capacity, according to development plans on file with BCMAF is 67,000 MT). Fish production is still low relative to capacity because of the lead time required for salmon to reach marketable size. Also, existing farms do not normally stock at capacity during start-up since operating capital is often limited. Although the number of sites in 1990 is expected to drop to 120, the impact on industry capacity will not be significant.

In 1988, the B.C. industry had an estimated 1,463 employees, including 808 full-time farm workers, 427 part-time, and 228 hatchery employees. According to a cost survey for rearing chinook salmon completed in June, 1989, the average farm on Vancouver Island (Campbell River area) employs about five full-time labour equivalents.

The salmon farming industry in B.C. is characterized by farms which raise salmon to market size in net pens in salt water. With this system, nets are sewn in a bag-like configuration and suspended from floating support structures.

With land-based and sea-based closed farming systems, fish are grown in tanks or bag-like structures which are installed on land or at sea. Water is circulated using pumps and generators. These systems are expected to yield lower mortality rates and to create a disease-free, controlled environment. Hagensborg Marine Farms based near Nanaimo, B.C. is the only commercial land based seawater facility in the province. Projected annual sales from sea trout are $3,000,000 annually and the farm employs approximately seven persons. The capital investment is large relative to the traditional net pen system and the long term feasibility of closed systems is still being assessed. Recent receivership appointments of Islandslax in Iceland and Landcatch in Scotland, two of the worlds largest land based systems, sheds further doubt on the long term viability of these systems.

Historical Developments in Other Countries

Though the B.C. salmon farming industry has grown rapidly to become fourth largest in the world, the industry remains small when compared to salmon farming in Norway. In a span of about 15 years, farmed salmon production in Norway increased from about 100 tonnes in 1971 to 117,000 MT in 1989 or about 140% of the entire catch of B.C. wild salmon.

Norway exports the majority of its farmed salmon production to France, Denmark and the United States. Markets for Norwegian farmed salmon production are summarized below for 1988.

TABLE 4

1988 Markets for Norwegian Farmed Salmon Production
(metric tonnes)

France	18,700
Denmark(1)	14,000
U.S.A	10,000
Germany	7,000
Sweden	3,000
Spain	2,900
Japan	2,500
U.K.	2,500
Belgium	2,200
Domestic and other	17,500
Total production	80,300

Note:

(1) The majority of the farmed salmon exported to Denmark is smoked and re-exported to the EEC.

Source: World Aquaculture, Vol. 20(2), June 1989.

The existing capacity of salmon farms in Norway is estimated to be about 157,000 MT and production is expected to be near that level in 1990. There are currently about 785 salmon farms in Norway employing about 4,000 individuals, an average of five employees per farm. Each farm has a holding capacity of about 200 MT based on a regulated limit of 12,000 M^3 in volume, (up from 8,000 M^3 in

1988), an 80% survival rate and a stocking density of 20 kg/M^3. There are also about 670 hatcheries in Norway with a total capacity of 217 million smolts per year.

At the present time, Norway produces the majority of the world farmed salmon production. However, commercial production is rising in many other countries including Scotland, Japan, Iceland, the United States and Chile. Table 5 shows 1988 worldwide production of farmed salmon for selected countries as well as estimates for 1989. Historical production by country between 1981 and 1989 is presented in Appendix 1.

TABLE 5

Worldwide Production of Farmed Salmon for Selected Countries
(metric tonnes)

	1988	1989
Norway	80,300	117,000
Scotland	17,600	28,500
Japan	14,060	17,100
British Columbia	6,950	12,400
Chile	3,100	6,680
Ireland	4,200	6,200
Faroe Island	3,400	6,000*
Eastern Canada	3,300	4,600
U.S.A.	1,900	4,000
New Zealand	1,650	2,000*
Iceland	1,300	1,800*
Other	2,190	3,420
	139,590	209,700

* Estimated

Source:

1989 production estimates are based on:
- Fish Farming International, January and February, 1990.
- DPA Group.
- For Canadian data, discussions with Governments and industry.

1988 Data:
- Fish Farmer Magazine, Jan./Feb., 1990.
- AAC Bulletin, 89-4.
- DPA Group.
- For Canadian data, discussion with Governments and industry.

As shown on Table 5, Scotland is the second largest producer of farmed salmon after Norway. Production in that country was 28,500 MT in 1989 up from a production of 17,600 MT in 1988 and only about 1,000 MT in 1981. Production in Scotland has grown at about the same rate as in Norway once a 1,000 MT production level had been achieved.

In 1989, there were 290 operating saltwater sites in Scotland which together employed 1,102 full-time and 316 part-time staff or an average of 4 full-time employees per farm. The total employment impact of the industry, however, is closer to 1,500 because of some 330 full-time and 87 part-time employees working in the smolt production industry and an estimated 350 in other companies supplying the industry.

Japan is the third largest producing country after Norway and Scotland. Production was 14,060 MT in 1988 and 17,100 MT in 1989. The industry in Japan has grown at about the same rate as in Norway once a production level of 1,000 MT had been reached. Japan produced about 1,000 MT in 1981 and about 7,000 MT five years later compared to Norway which reached about 1,500 MT in 1976 and 8,900 MT five years later.

In summary, the salmon farming industry has been gaining momentum not only in British Columbia but throughout the world. The next two sections review the constraints and opportunities facing the B.C. industry.

Constraints Facing the B.C. Industry

The major constraints facing the B.C. industry are as follows:

- Marketing;
- Production;
- Financing;
- Research and development; and
- Attitudes of other natural resource user groups.

Marketing

Marketing is becoming more important as a constraint to industry growth. Salmon production has been growing with farmed salmon expected to account for about one third of worldwide salmon production by the year 2000. Other factors which are likely to increase competition include a move towards globalization of markets and increased competition from other fish species. At the same time, there are a number of demand related factors which could increase salmon consumption over the next decade including: the aging and growing population; the move towards more health conscious diets; and higher discretionary income levels.

Salmon prices worldwide have been sensitive to supply changes and increased competition on world markets. For example, between 1986 and 1987, salmon prices increased, partly reflecting the lower catch of wild salmon. Between 1987 and 1989, salmon prices dropped by at least 25% due to increasing world supplies, not just from salmon farming but also from a record catch of Alaska salmon. Norwegian farmed salmon production in 1989 was also said to have put downward pressure on world prices.

Salmon prices will continue to face downward pressures over the next decade as salmon production is expected to increase. On the other hand, the high production quality and consistent supply of farmed salmon could put upward pressures on prices. In any event, marketing will play an increasingly important role in salmon farming. To gain a share of the increasingly competitive salmon market, the farmed salmon industry will have to capitalize on its ability to give consumers a consistent supply of fresh, high quality product. Close proximity to markets and new market initiatives such as value-added processing will become increasingly important as competition increases.

Production

Production levels of farmed salmon in B.C. have been affected by high mortality rates due to algae blooms, disease, and other biophysical factors associated with raising previously undomesticated Pacific salmon species.

Health related factors which can limit production and affect mortality rates significantly include:

- A few species of plankton are harmful to fish, and when they occur in large numbers ('blooms'), they can cause mortalities of fish and other organisms. In 1987, a plankton bloom was responsible for a loss in production in Norway of about 5,000 MT, representing about 10% of production. Plankton blooms have also been experienced in certain regions of B.C., particularly the Sunshine Coast area. In September, 1989 an algae bloom of Heterosigma and Chaetoceros swept through the waters of the Agamemnon Channel and Jervis Inlet. Losses were estimated at $2,000,000, about 2% of B.C. annual farmed production. Plankton blooms and other diseases affect wild fish as well as farmed fish although the concentration of farmed fish in one area increases the likelihood of heavy losses.

- Certain bacteria affect internal organs of the fish and can cause death or reduce weight gain, as is the case with Bacterial Kidney Disease (BKD), one of the most problematic diseases facing the industry at this time.

There are a number of vaccines and production techniques which prevent the occurrence of diseases. The industry is continuing to develop new vaccines and production methods and is researching the various diseases.

B.C. has also experienced some difficulties with raising Pacific salmon species:

- Norway and EEC countries grow only Atlantic salmon and initially, B.C. attempted to grow Pacific salmon using the same guidelines as those used for Atlantic salmon. In fact, Pacific salmon proved to require densities of 4 to 8 kg. per M^3 compared to between 15 and 20 kg per M^3 with Atlantic salmon. The industry is now rearing Pacific salmon successfully but it continues to search for ways to lower mortality rates, increase rearing densities and improve production characteristics.

- The B.C. industry experienced difficulties in rearing coho stocks to marketable sizes within a consistent time frame as experiments undertaken to grow neutered coho (fish genetically engineered to have no male characteristics) were largely unsuccessful. Coho production will continue to fall over the next few years. Now that chinook smolts are available, the industry is primarily growing chinook salmon, and it is expected to be the dominant species for at least the next five years.

- The B.C. industry is also growing Atlantic salmon with 1989 production of Atlantic salmon accounting for about 10% of farmed salmon production. While growing Atlantic salmon on the West Coast is gaining in popularity, the industry is expected to continue to grow predominantly coho and chinook, at least over the next few years.

Financing

Salmon farms require a significant capital investment not only for pens and installations but also to provide for initial operating expenses. The Canadian banking community has been reluctant to provide financing to the industry until at least one complete crop cycle has been completed. Several Norwegian banks have, however, financed farms in B.C. in the past. The government programs which provide financial assistance to the industry contribute primarily to capital expenditures. At the provincial level, the Agriculture Credit Act and the Small Business Venture Capital Program provide loan guarantees and venture capital for a selected number of industry sectors, including aquaculture. At the Federal level, the Aquaculture Incentive Program provides support to aquaculture farms as does the Western Diversification Fund although on a selected basis. Despite these programs, direct financial assistance from government to B.C. salmon farms has constituted a relatively small proportion of capital employed in the industry since 1985.

Research and Development

Salmon farming in B.C. is still at the development stage, requiring ongoing research. There are still many unknowns regarding diseases, genetic enhancement, feed conversion factors and other production-related matters. As described earlier, the industry is also experimenting with new technologies including land-based and ocean-based closed farming systems, and rearing of other species of finfish.

Attitudes of Other Groups

Participants in the commercial and recreational fishing industry as well as other groups have voiced their concerns about the potential genetic and environmental impact of fish farms on wild fish stocks. Restrictions on the distance between farms, controls on rearing Atlantic stocks, and other regulations are in place to limit the likelihood of any negative impacts on the wild fisheries.

The B.C. salmon farming industry is also attracting some negative publicity from local residents and recreational users of the shoreline. Concerns vary from environmental impacts to industrialization of the public shoreline. The B.C. salmon aquaculture industry is located primarily on the south coast of the province and on Vancouver Island. Accordingly, some of the farms are located in populated regions where recreational boating and sports fishing is popular.

Strengths of the Industry

There are many countries like Chile, Scotland, and the U.K. with significant investments in salmon farming. The comparative advantage of British Columbia is examined in a number of areas including:

- Proximity to markets;
- Production costs;
- Availability of sites;
- Expertise and infrastructure; and
- Government regulations.

Proximity to Markets

B.C. is close to the United States, one of the largest potential markets for farmed salmon. One important cost of production is transportation to market. Farmed salmon is typically sold fresh and accordingly, it should be delivered to markets within two days of processing. As described earlier, exports of farmed salmon from Norway to the United States was about 10,000 MT in 1988. When delivering to the U.S., Norway producers incur air freight delivery costs of about C$ 2.80 per kg or about 35% of total delivered costs. Freight costs from B.C. are a fraction of this amount.

Japan is a large potential market for farmed salmon, and B.C. can supply that market at a lower cost than Norway. Japan is becoming a major producer of farmed salmon, (20,000-24,000 MT predicted for 1990) but current and potential production is limited by warm water temperatures in the summer and the lack of available sites.

Production Costs

The production cost of farmed salmon depends on a number of factors including mortality rates, farm capacity, and the cost of feed, labour, and capital. The major operating cost components of farmed salmon production are labour and feed costs. The following table compares selected cost components for Norway, Scotland and British Columbia.

TABLE 6

Comparative Cost Components for Norway, Scotland and Canada

	Norway	Scotland	British Columbia[1]
Feed (C$ per kg of feed)	$1.40	$1.20	$1.05
Wages and salaries (C$)			
• Farm staff - per annum	$27,000	$15,000	$25,000
• Packers - per hour	$13/hr	$5/hr	$12/hr
Interest[2]	14.4%	15%	13.5%

Notes:

(1) Wages and salaries would be lower in Eastern Canada.

(2) Interest rates in Fall, 1989, International Monetary Fund.

Source: B.C. Ministry of Agriculture and Fisheries and discussions with industry.

As shown in this table, Norway has the highest delivered feed costs at C$1.40 per kg of feed compared with C$1.20/kg in Scotland and C$1.05/kg in Canada. Although not indicated in this table, the cost of feed in Chile is very competitive. Chile is a major exporter of fish meal, one of the major raw materials for dry feeds.

Table 8 also shows that B.C. has wages and salaries which are lower than in Norway but are higher than in Scotland. Although not shown in this table, labour costs in Chile are much lower than in

Canada and Scotland. Further, wages and salaries in B.C. may increase particularly if the industry becomes unionized.

While unit cost components provide interesting comparisions, they need to be reviewed in conjunction with feed conversion ratios, growth rates and other operating conditions prevailing in individual countries. This is particularly so because Norway and Scotland grow primarily Atlantic salmon whereas B.C. has been growing coho and chinook salmon. Recent comparative cost of production data are not readily available and they are not discussed further in this report.

Exchange rate is an important factor in comparing the costs of production between the various countries. Wide variations in exchange rates significantly alter the relative competitive position of salmon producers worldwide, provided producers are serving the same markets. Under the present rate structure, the B.C. farmed salmon cost of production is about the same as in Norway but it is higher than in Scotland and Chile. Similarly, transportation costs will influence relative production costs, particularly as a result of the emphasis on efficient distribution for fresh products.

Availability of Sites

British Columbia has 27,000 kilometres of coast line and sheltered inlets and an almost unlimited supply of sites which are biologically suitable for fish farming. Selecting a site, however, depends on a number of factors including:

- Proximity to markets and access to transportation routes;
- Availability of and delivered costs of feed and other supplies and services;
- Proximity to sources of pollution; and
- Level of flushing action so as to maintain high dissolved oxygen concentrations in the water and remove fish wastes.

The industry worldwide generally agrees that in terms of sites and water quality, the environment in B.C. is better than that in Norway. Norway's coastal waters are relatively shallow in comparison to B.C. and the tidal flux on the open waters of the North Sea is significantly less than tides in the Pacific Northwest. This contributes to the pollution problems experienced in Norway as water exchange with the open sea is more restricted in Norway's fjords than in B.C.

At the present time, the majority of the operating sites in B.C. are around Vancouver Island and on the Sunshine Coast. As of January, 1990, only seven licences were in the Price Rupert North Coast Region, 68 were on the Sunshine Coast/Lower Mainland Region, and the balance or 138 (10 leases and 128 licences) were on Vancouver Island. Nevertheless, there are still numerous available sites

suitable for farmed salmon production, particularly on the northwest coast of Vancouver Island (33 investigative permits issued).

Expertise and Infrastructure

British Columbia has a well trained workforce, a large pool of research scientists and a well developed network of hatcheries and other organizations supplying the industry:

- B.C. has widespread technical and industry knowledge in hatchery and related fields. In developing wild salmon stocks, the Salmonid Enhancement Program (SEP) also assisted in creating an understanding of the hatching process for salmon. This expertise is directly transferable to the salmon farming industry and has facilitated the development of private hatcheries.

- In 1989, there were 40 hatcheries in B.C., about half of which were combined with grow-out sites. The industry in British Columbia is now considered to be self sufficient in terms of egg production. In 1989, the industry produced 29 million smolts of which 24 million were chinook, three million were coho and two million were Atlantic smolts.

- Because of the importance of the wild salmon fishery, local universities as well as governments have well developed research facilities and programs in oceanography and other related fields. Several technical and college programs now offer aquaculture programs leading to certification.

- A number of large companies which have processed and marketed wild salmon in the past are now entering joint venture agreements with aquaculture farms to market and distribute their products.

Government Regulations

B.C. salmon farming government regulations pertaining to the environment, pollution, sea traffic and recreational uses are comparable to those in place in Norway and Scotland but they are more stringent than in Chile. In that country, environmental issues are less of a concern, particularly since Chile has no wild salmon fishery.

The industry in Norway is also regulated on the marketing front contrary to the position in B.C. The industry in Norway has a marketing organization which collects revenues on all sales of farmed products as well as controling other marketing aspects, much like a Marketing Board. In B.C., the industry has not yet coordinated its marketing function, although the B.C. Salmon Farmers Association has tried to promote farmed salmon in recent years. Also, in Norway size and ownership of Norwegian salmon farms have been restricted to fulfil regional development policies. Partly because of these regulations, Norwegian companies have been investing heavily in B.C. and elsewhere.

Outlook to the Year 2000

The purpose of this section is to project the size of the salmon farming industry to the year 2000. Because of the dynamic nature of the salmon farming industry, not only in British Columbia but worldwide, three different scenarios are developed, namely high, moderate and low industry growth. These projections are summarized in Table 9 and are described in the following sections.

TABLE 7

Outlook to the Year 2000

B.C. Farming Salmon Industry

	Production(MT)		Number of Sites		Full-time Equivalent Employment[1]	
	1995	2000	1995	2000	1995	2000
High growth	30,000	60,000	200	300	1,050	1,800
Medium growth	25,000	50,000	175	225	1,000	1,400
Low growth	20,000	30,000	150	175	950	1,000

Note:

(1) Employment estimates are based on an average of between five or six full-time equivalent employees at each site depending on the scenario; this is slightly higher than the estimated 4.5 full-time equivalent employees per average farm on Vancouver Island to account for the larger expected capacity. They exclude employment at hatcheries and other organizations supplying the salmon farms.

High Growth Scenario

Under a high growth scenario, the B.C. industry will continue to grow aggressively and follow, to some degree, the Norwegian experience. As previously mentioned, in just 18 years the industry in Norway grew from producing about 100 MT in 1971 to producing about 117,000 MT in 1989.

Outlook to 1995:

Conditions in B.C. are different than in Norway, and the pattern of growth in B.C. in production to the year 1995 is not expected to follow that of Norway. However, a high growth scenario suggests that B.C. could produce as much as 30,000 MT by 1995. The precise annual production schedule is difficult to predict because of such factors as disease, mortality rates and overall yields.

B.C.'s 1987 production level was around 1,200 MT, about the same as Norway's production in 1976. After 1976, it took nine years for Norway to reach about 30,000 MT and another three to reach 50,000 MT. B.C. will likely reach the 30,000 MT level by 1995 or one year less than it took Norway to progress to this point from the 1,000 MT level. This is primarily because farmed salmon holding capacity in B.C. is already at about 27,000 MT, although production is still only a fraction of this capacity (about half).

This rate of growth is consistent with that experienced in Scotland. Scotland reached the 28,500 MT level in 1989 or about eight years after production reached 1,000 MT. Japan is growing at a slower rate but conditions there are not comparable to those in B.C. Japanese production is constrained by the lack of available sites and the fact that the fish must be harvested by August before the warm water kills them.

The number of sites required to achieve a 30,000 MT production level by the year 1995 is estimated at 200. This figure is based on an average site capacity of 200 MT, the current average capacity for farms in B.C. It also assumes that about half of the farms or 100 will be producing at 100% capacity while the other half will be entering the industry and producing about half of their sustainable annual average production level of 200 MT. On that basis, the 30,000 MT production level achieved in 1995 will equal about 75% of the overall holding capacity of some 40,000 MT (200 MT per site and 200 sites).

The number of sites could be lower than the estimated 200 if capacity per site increases as existing farms invest in new capacity. However, experience in Scotland shows that companies tend to increase production by increasing the number of sites rather than capacity at each site. This allows companies to diversify the risks related to disease at any one site. In Scotland, the average site ranges between 150 MT and 200 MT.

Projected direct employment by the 200 B.C. fish farms will likely reach about 1,000 by 1995. This is based on an estimated five full-time equivalent positions per site, or about the current level of employment per operating site in B.C.

The 1,000 projected employment level translates to about 40 MT of production capacity per direct job based on 200 sites of about 200 MT average capacity. This level is comparable to that in Norway. Employment in Norway is currently estimated at 4,000 direct farm related jobs for a production level of 117,000 MT in 1989 and a capacity level of 150,000 MT. This translates to between 30 and 40 MT per direct job.

In addition to direct employment in fish farms, the industry will create indirect employment in aquaculture service industries such as feed supplies, hatcheries and equipment dealers.

Outlook to 2000:

Provided that B.C. reaches some 30,000 MT in production by the year 1995, it is possible that B.C. could reach a production level ranging between 60,000 MT to 80,000 MT by the year 2000 thereby duplicating somewhat the Norwegian experience. As previously mentioned, farmed salmon production in Norway is expected to be 150,000 MT in 1990 compared to 28,655 MT in 1985. Although the achievement of such a high production level is conceivable, there are a number of factors such as site availability, market constraints and increased competition from other countries which are likely to prevent the B.C. industry from reaching that level. Under these conditions, a projected production of 60,000 MT by the year 2000 is a realistic high growth scenario.

The number of sites required to achieve this 60,000 MT production level by the year 2000 is estimated at 300. This is based on a holding capacity of 270 MT, a larger and more efficient farm than what is currently the case in B.C. and an average production level equal to about 75% of the overall holding capacity.

Direct employment by the 300 farms is estimated to be around 1,800 direct employees based on an average of six employees per farm. This is slightly higher than the estimated current employment per farm to account for the larger expected capacity. This excludes indirect employment in hatcheries and other related industries.

Underlying Assumptions:

In order for the industry to reach a production of 30,000 MT by 1995 and 60,000 MT by the year 2000, there are a number of factors which will have to be overcome. These include:

- Profitability in the industry will have to be demonstrated. There are currently only a few farms recording positive cash flows. However, before the industry sees an increase in the number of sites and farms, existing operations will have to demonstrate greater levels of profitability.

- Market prices will have to rise above 1989 levels so as to encourage further investment in the industry. World supplies of salmon and particularly farmed salmon are expected to rise

significantly in the next decade. Projected world salmon production to the year 2000 is reported in Table 8 following. As shown in that table, farmed salmon is expected to account for about one third of total world supplies of salmon by the year 2000. While world salmon supplies are expected to increase by about 30% between 1988 and 2000, the demand for fresh fish also has the potential to increase, such that prices could potentially increase from current 1989 levels. This is particularly so because farmed salmon allows year round supply of fresh fish of a high quality.

TABLE 8

Total Projected Supplies of Salmon by Country in 2000
(000's of metric tonnes)

	Wild		Farmed		Total	
	1988	**2000**	**1988**	**2000**	**1988**	**2000**
U.S.A.	250	355	2	6	252	361
Japan	175	227	14	15	189	242
Norway	75	-	80	200	155	200
U.S.S.R.	120	107	-	-	120	107
Canada	85	93	10	39	95	132
Other	40	-	34	98	74	98
Total	745	782	140	358	885	1,140

Source:

- Projections to the year 2000 are from 'Perspectives on Worldwide Salmon Supplies to the Year 2000', Peter Leitz of the Department of Fisheries and Oceans and David Egan of the DPA Group Inc., proceedings to the 1988 Aquaculture International Conference.
- 1988 wild catch supply figures are from the B.C. Ministry of Agriculture and Fisheries and the Department of Fisheries and Oceans.

- As shown in Table 8, the production of wild salmon is expected to remain relatively stable but production of farmed salmon is expected to more than double. Since most farmed salmon is currently sold fresh or smoked at premium prices, the price of these salmon products can be expected to drop unless the demand increases significantly.

- In the short-term, salmon prices have been sensitive to supply changes. For example, between 1986 and 1987, salmon prices increased by about 20% reflecting the much smaller 1987 catch, whereas from 1987 to 1989, prices have dropped at least 25% to reflect increasing world supply. In the longer-term, demand may increase such that increased supplies will have limited impact on prices. Consumption per capita in North America is about one quarter of that in Japan and there is potential for market demand to increase with the availability of fresh fish year round and with increased advertising. Per capita consumption of fish and shellfish for selected countries is summarized in Table 9.

TABLE 9

Consumption of Fish and Shellfish Per Capita

	Canada[1]	U.S.A.[2]
Edible weight (kg per capita)		
1970	4.9	5.4
1988	6.8	6.8

Live weight equivalent (kg per capita)[2]

Japan	86 kg
Norway	49
France	24
Canada	21
U.S.	17
West Germany	15

Note: Excludes consumption of recreationally caught fish and shellfish.

Source:

(1) Statistics Canada, 'Apparent Per Capita Food Consumption in Canada', catalogue 32-230.

(2) Fisheries of the United States, U.S. Department of Commerce, Washington, D.C. April 1988.

- While prices will have to increase from existing levels for these production levels to materialize, salmon farms will also be required to contain production costs. The foreign exchange rate between Canada and other producing countries is an important factor in assessing the competitiveness of the industry in U.S. markets. This scenario assumes the elative rates of exchange will not worsen from existing levels.

- Feed costs are also important in assessing the competitiveness of the various regions since they account for approximately 40 to 50% of direct production costs. This high growth scenario assumes that the cost of feed in B.C. will remain approximately the same relative to the cost paid by other countries. This is a reasonable assumption given that B.C. producers already pay world prices for fish meal and fish oil. At present, aquaculture feeds use only about 10% of the worlds production of approximately 6.5 million tonnes of fish meal. World salmon farmers are using about 90% of fish meal produced for salmon farms.

- This scenario assumes that the industry will not suffer major widespread disease related problems. Plankton blooms and diseases will continue to occur, however, it is assumed that these occurrences will be localized and affect a small percentage of industry production in any given year.

- The high growth scenario is based on the current technology of net pens operating in sea water. Technological changes and particularly the feasibility of land-based and other closed systems could improve the profitability of the industry and result in higher than projected growth. The industry is currently experimenting with various land-based techniques and other systems, however they are not expected to have a production impact for the next three to five years. If successful, land-based and other techniques may partially displace the current systems. However, it is unlikely that these techniques will have any significant impact on production until at least 1995.

- The achievement of this production level assumes that the new entrants will succeed in obtaining capital during the early years of development. This is a plausible assumption particularly once the industry has proved its profitability. Concentration in the industry may continue to develop, however, as established companies finance the development of new sites while smaller operations continue to be prevented from expanding because of the relatively large initial capital requirement and high interest rates. Rationalization may also occur through mergers and acquisitions, but this will likely impact on the number of companies and the ownership structure rather than the number of sites and production levels.

In summary, by the year 2000, the B.C. salmon farming industry has the potential to produce about 60,000 MT, or approximately 70% of B.C.'s commercial catch of wild salmon in 1988. For these projections to materialize, salmon prices will have to increase from existing levels and the industry must become profitable and contain production costs at reasonable levels. The next section presents a low growth scenario for the industry.

Low Growth Scenario

Outlook to the Year 2000:

In 1989, British Columbia had about 135 operating sites with an estimated capacity of about 27,000 MT. Under a worse case scenario, the B.C. farmed salmon production will continue to grow for the next five years up to say 20,000 MT and then plateau as increased farmed fish production is achieved world wide. Production will continue to increase to say 30,000 MT by the year 2000 but primarily because the industry will mature and produce at full capacity. Under this scenario, the

number of sites will likely increase to say 175 by the year 2000 and employment will level off at about 1,050 full-time workers.

Assumptions:

This scenario assumes that the growth in farmed salmon production will be negatively impacted by marketing and production problems particularly in the next five to seven years:

- The production of farmed salmon will probably double by the year 1995 which will increase the supply of salmon worldwide by about 150,000 MT. This scenario assumes that prices will not rise above 1989 levels (excluding inflation adjustments) and assumes that existing sites will be able to continue to cover operating costs despite continuing levels of depressed salmon prices. However, while existing farms will cover operating costs, investments in the industry will likely slow considerably, thereby restricting future production. Moreover, existing price levels could be devastating for farms entering the industry and may result in further rationalization.

  The assumption that the salmon farming industry in B.C. could survive at 1989 price levels is reasonable. In 1988 production costs were between $2.50 and $3.50 per pound at the farm, depending on what cost are included ($5.50/kg to $7.70/kg). With 1989 prices around $3.75 per pound ($8.25/kg.). B.C. farms were making only small profits, if any. Management will be pressured to reduce these costs even further in the future but it is reasonable to expect some potential for further production efficiencies at existing sites.

- The industry is subject to significant risks related to plankton blooms and fish diseases. Research and development by governments and individual farms is essential to allow the industry to grow and reach its production potential. In 1989, the State of Washington salmon farming industry was negatively impacted by a previously unknown virus affecting the fish. Similar occurrences could impact on the B.C. industry.

Other underlying assumptions are as follows:

- Although there are other countries in the same start-up position as B.C., production from these countries is unlikely to increase at a much faster rate than in B.C. Countries in a similar start up position as B.C. include New Zealand and Chile.

- The industry is very knowledge and technology intensive. This creates some barriers to entry for other countries which are not yet active in the industry. However, as technology becomes more widely known, transfer to other geographical areas becomes easier.

- The State of Alaska, a potential major competitor to B.C. has instituted a moratorium on farmed salmon production for fear of damaging the wild fishing stocks. Provided that these fears are alleviated, the State of Alaska may become a major producer of farmed salmon by the end of the 1990's.

- The States of Washington and Oregon may also become major producers of farmed salmon, particularly if land based and other less pollution prone systems prove economically feasible. In the near future, however, these regions are not likely to become major players in the industry. The coast line of these states is more populated than in B.C. and industry growth is being constrained by opposition from environmental groups and local residents.

Beyond 1995, B.C. may continue to be constrained by world supply forces and increased competition from other fish farming countries as follows:

- The market for salmon may face increasing competition from the farming of other fin-fish including trout, arctic char, halibut, and cod. As a result, prices for farmed salmon may not rise overtime, thereby reducing the attractiveness of the industry. Trout production is currently very large in certain countries including the United States, France and other EEC countries. While the production of other fin-fish like cod and halibut is currently at an experimental stage, commercial farms will likely begin operation within the next five years. Depending on the feasibility of these operations, increased production of these products could have a negative impact on salmon prices.

- Salmon markets could also become saturated if the industry fails to attract larger numbers of North American consumers to the product. As described earlier, North Americans consume considerably less fish on a per capita basis compared to the Japanese. The industry is relying on this gap narrowing. However, encouraging consumers to eat more fish will require extensive marketing and a continuing trend toward health consciousness.

- The market for farmed salmon could also be negatively impacted if the product is perceived by consumers to be of lower quality or potentially unsafe.

- The market for farmed salmon could also be negatively impacted by more aggressive marketing by wild salmon producers, assuming world supplies continue to be a major factor in the marketplace.

- B.C. is likely to face increasing competition from the U.S. Pacific Northwest and Alaska in the U.S. market. This is particularly the case if land-based producing techniques prove profitable, and environmental impacts are no longer a major concern.

- B.C. may continue to lose its cost advantage relative to Chile and other developing countries. At the present time, the technology is fairly new and B.C. benefits from a well-educated labour force and a well-established fisheries infrastructure. As the industry matures, less developed countries could become more competitive particularly as the cost of labour in those countries is much less than labour costs in North America.

Medium Growth Scenario

A middle-of-the-road scenario is for the British Columbia industry to reach a production level of about 50,000 MT by the year 2000. Under this scenario, by the year 2000, there would be about 225 sites in operation employing an estimated 1,400 employees.

This scenario essentially presents a mid-point between the high and low growth scenarios. Major underlying assumptions are as follows:

- Disappointing market prices in the next five years will impact negatively on investments as banks and private investors will be reluctant to invest in the industry. This will delay the growth in the number of sites and in production.

- Production problems may limit industry growth in the next five to seven years thereby delaying significant investments in capacity. Current capacity is estimated at around 27,000 MT but production is still only 50% of this capacity. Salmon farm production is subject to diseases and other risks such that it could take until 1995 for the industry to reach higher capacity utilization rates and produce 25,000 MT.

- This scenario assumes that investments will be strong beyond 1995 as B.C. resolves some of its marketing and production related problems within the next five years. Because of the time lag in producing farmed salmon and producing at capacity, investments made between 1995 and 1997 will only start paying off by the year 2000.

- B.C. will face increasing competition from the United States, Chile and other countries and these countries may be the recipients of foreign and domestic investments rather than B.C. This scenario assumes that markets for farmed salmon will be sufficiently strong throughout the 1990's to encourage further investments in capacity.

Conclusion

In conclusion, the B.C. salmon industry will probably achieve a production rate of between 30,000 and 60,000 MT by the year 2000. The number of sites operating in B.C. is expected to range between 175 and 300 and direct employment is likely to be between 1,050 and 1,800. This excludes considerable indirect employment which will result from industries supplying the industry such as hatcheries, equipment manufacturers, processing plants, and feed suppliers.

Chapter 2 - The Salmon Farming Industry in Eastern Canada

Historical Development of Salmon Farming in Eastern Canada

The salmon farming industry in Eastern Canada is concentrated in the Bay of Fundy in New Brunswick and to a lesser extent in Nova Scotia. Attempts to grow salmon in sea cages in Eastern Canada were undertaken in Nova Scotia in 1969 and in New Brunswick in the 1970's. These attempts were unsuccessful because of extreme water temperatures in the winter. The first successful trials were conducted in the late 1970's at Lord's Cove on Deer Island N.B. with funding assistance provided by governments and industry.

Table 10 summarizes the number of sites and volume of salmon aquaculture production in the Bay of Fundy on the New Brunswick coast between 1979 and 1989. Salmon production for Nova Scotia and other Atlantic provinces during that period has been growing but it remains relatively small.

As shown on table 10, there were 49 operating salmon farms in the Bay of Fundy in 1989, up from 34 in 1987. Together these farms produced 4,250 MT of salmon in 1989.

In 1988, the average Bay of Fundy salmon farm employed five employees and it had a production capacity estimated at about 140 MT. This was based on each farm utilizing an average of 16 cages, 2,500 to 3,000 fish per sea cage, an 88% survival rate, and an average weight of 8 lbs per marketable fish sold[1]. In early 1990, the average farm capacity was estimated to be higher - between 150 and 200 MT - as 22 of the farms operating in the Bay of Fundy are planning expansions.

Based on 49 sites currently in operation and an average production capacity of 175 MT per farm, the existing capacity of the industry is estimated at about 8,500 MT. As is the case in British Columbia, fish production is still smaller than capacity because of the lead time required for salmon to reach marketable size and because farms do not necessarily stock at full capacity especially during start-up.

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[1]Robert H. Cook, 'Salmon Aquaculture in the Bay of Fundy: A Quiet Success' Aquaculture Association of Canada; Edition 88-2, June, 1988

TABLE 10

Salmon Aquaculture Production in the Bay of Fundy, New Brunswick, 1979 - 1989

Year	Number of farms	Production (MT)	Average Price/kg ($)	Value ($000's)
1979	1	6	7.78	$ 49
1980	2	11	7.26	82
1981	4	21	7.50	156
1982	5	38	8.27	315
1983	5	68	9.93	675
1984	10	222	11.58	2,572
1985	20	349	12.02	4,197
1986	28	635	12.72	8,078
1987	34	1,315	14.00	18,415
1988	34	3,250	N/A	32,000
1989	49	4,250	N/A	32,075

Source:

Robert H. Cook, 'Salmon Aquaculture in the Bay of Fundy: A Quiet Success' Aquaculture Association of Canada; Edition 88-2, June, 1988.

Department of Fisheries and Oceans, Canada

The salmon farming industry in Nova Scotia is smaller than in New Brunswick and a large portion of the sites grow a combination of marine rainbow trouts and salmon. In Nova Scotia, there are eight hatcheries and 18 operating sites: eight sites grow a combination of marine trout and salmon and the other ten grow only marine trout. There is one major land based facility in operation.

In 1989, the production of farmed salmon in Nova Scotia was 145 MT up from 27 MT in 1988. In addition, marine rainbow trout production was 184 MT in 1989 compared to 171 MT in 1988. Nova Scotia production in 1989 was lower than was initially anticipated because of mortality problems at some of the farms, the selling of stocks earlier and at lower weight than expected at one of the farms, and some of the farms holding onto stocks due to lower than expected prices.

Salmon farming in Quebec and P.E.I. is limited to land based facilities because of severe winter water temperatures and ice. There is one land-based commercial Atlantic salmon farm in the Baie des Chaleurs in the Gaspe peninsula and another one in Georgetown, P.E.I. The farm in Quebec is expecting to produce in the neighbourhood of 500 MT within the next few years although production was lower than expected in 1989/90 due to bacterial disease. The P.E.I. operation is in receivership for the second time in two years after having experienced operating difficulties. To date, production at the P.E.I. site has been limited to marine rainbow trout.

Salmon aquaculture in Newfoundland is at an experimental stage. The industry suffered a major setback in 1988 when about 450,000 farmed salmon, smolts, and market fish were destroyed. The reason for this was the low marketability of the fish resulting from poor quality of the original broodstock. This represents virtually all of the stock of farmed salmon in Southern Newfoundland. There is one hatchery in operation in Newfoundland and it expects to have smolts ready for transfer to sea cages later this year for production in 1991. In the meantime the hatchery has been supporting a couple of marine trout farms.

Constraints

The following describes the major constraints facing the industry in Eastern Canada in a number of areas, namely:

- Site availability;
- Marketing;
- Production;
- Financing;
- Attitudes of other interest groups; and
- Smolt production (in Newfoundland).

Site Availability

The limited availability of suitable sites for sea cage operations can act as a constraint facing salmon farming in Eastern Canada. Some coastal Atlantic regions have proved too cold for rearing salmon. It is also possible that cage sites which may be suitable for rearing salmon over a number of years can experience lethal temperatures in particularly cold years.

In Eastern Canada the most suitable sites for sea cage operations are limited to the Bay of Fundy in New Brunswick, and particularly to a small area near Passamaquoddy Bay, as well as along the coast of Nova Scotia.

The lack of suitable sites for sea cage farming will restrict production from Eastern Canada unless land-based systems prove to be cost effective. There are some land-based farms in Eastern Canada, although their overall profitability has been questionable:

- The only salmon farm in Quebec, a land-based operation, has been somewhat successful but probably because the farm produces its own feed as well as its own smolts. While production results in 1989 were lower than expected because of bacterial disease, the farm is planning to produce in the range of 500 MT within a few years.

- Prince Edward Island has a large indoor salmon and trout growing facility in Georgetown. The farm was initially built by Norwegian and Canadian investors with financial assistance from governments which approved a loan guarantee and a low interest rate loan. The province also allocated some job creation grants. The original investor incurred financial troubles in late 1988 and the farm was operated by the receiver until summer 1989 when it was sold at a major loss to a third party. In February 1990 the farm was put in receivership for a second time. As mentioned earlier, production to date has been limited to marine trout.

Marketing

Markets have not been a significant constraint to growth up until recently when salmon prices world wide dropped significantly. Prices for Atlantic salmon have been reported as follows:

TABLE 11

Atlantic New Brunswick Salmon Prices

	August 1989		December 1989	
	Per lb.	Per kg.	Per lb.	Per kg.
6 - 9 lbs.	4.75	10.45	3.83	8.43
9 and larger	5.00	11.00	4.23	9.31

Source: Canadian Aquaculture, January/February 1990 issue.

As of March 1990, prices for Atlantic salmon have increased to about 5.00 per lb. ($11.00/kg.) as prices worldwide seem to have stabilized. The situation in the long term is not clear. As indicated, world supplies of salmon are expected to increase significantly by the year 2000, primarily because farmed salmon production worldwide is expected to more than double. Unless this supply increase is

matched by an increase in demand, salmon prices could face a number of downward pressures over the next decade.

Production

As is the case in B.C., there are a number of diseases which could limit production and affect mortality rates, including some diseases such as ulcerative dermal necrosis (UDN). This disease has not yet been found in Canada but has devastated many Atlantic salmon populations in Europe. The industry, however, has been monitoring the development and the occurrence of diseases and improving on vaccines administered to fish.

Financing

The lack of financing available to salmon farms, particularly during start-up, has been a growing concern. With the prime rate having increased significantly in 1989 and early 1990 and relatively low salmon prices, financing concerns are becoming more critical.

While high interest rates and low salmon prices are impacting on industry profitability in New Brunswick, up until now the industry has not witnessed the widespread number of bankruptcies experienced on the West Coast. Reasons explaining this include the maturity of East Coast farms relative to those on the Pacific Coast, different production conditions, proximity to the large Eastern U.S. and Canadian markets, competitive cost of production and government regulations which controlled industry growth thereby preventing the surge in new sites and farms experienced in B.C. in 1986 and 1987.

Attitudes of Other Interest Groups

Environmental issues are of concern primarily in the Bay of Fundy area where industry has been more concentrated. In that region, the rapid growth of sea cages has raised opposition from the traditional fishery. The weir fishery is concerned that sea cage operations may deter sardine schools from moving inshore and entering the weirs. Also, local clam diggers are concerned that sea cage operations could impact negatively on adjacent commercial clam flats.

On the east coast of Nova Scotia, concerns have been expressed concerning the effect of aquaculture activity on property values, and possible competition for waterways between aquaculture, commercial fishing and recreation.

Smolt Production

In Newfoundland smolt production has been problematic. Fish farms in Newfoundland have had disappointing results due to lack of identification of a high quality broodstock, slow growth rates and early maturity of the fish. The Bay d'Espoir hatchery has imported smolts from other provinces and is now rebuilding its stocks.

Smolt production is not a constraint to growth in the rest of Atlantic Canada. While smolt production restricted the growth of the industry in New Brunswick up until a couple of years ago, production has been expanding rapidly at the four major hatcheries and eight medium to small hatcheries located in the province. There are eight hatchery sites in Nova Scotia and smolt production has not restricted industry growth in that province either.

Strengths of the Industry

The comparative advantages of Eastern Canada are discussed in the following sections in a number of areas namely:

- Proximity to markets;
- Production costs;
- Experience and infrastructure; and
- Government regulations;

Proximity to Markets

Except for Newfoundland, the Atlantic provinces are in close proximity to Montreal and Toronto as well as the Eastern United States markets. Fish grown in the Atlantic provinces are within 6 to 12 hours of these large markets, an important advantage given that farmed salmon is typically sold fresh.

Production Costs

The cost of production of farmed salmon depends on a number of factors including the mortality rate, farm capacity and the cost of feed, labour, and capital. The possibility of winter kills in Eastern Canada waters including the Bay of Fundy increases the risks of farming in that region. Notwithstanding that risk, however, the cost of producing farmed salmon in Eastern Canada is competitive.

The Atlantic provinces have one of the major herring fisheries in the world. As a result, there are already some manufacturers of moist, as well as dry feeds, and additional feed manufacturing capacity is being planned.

Labour costs in Eastern Canada are also competitive. In a study which was conducted in 1988 on behalf of the Department of Fisheries and Oceans and the New Brunswick government[2], fish farm employees were reported to earn an average of $19,200 a year including benefits. This is lower than the cost of labour in B.C. and in Norway of around C$25,000 and C$27,000 respectively but it is higher than the C$15,000 paid in Scotland. Wide fluctuations in exchange rates can significantly affect the relative production costs between countries in any given year. More recent consistent data for all three countries are not available but the situation, at least in Eastern Canada, is not expected to have changed.

The 1988 operating costs before interest and taxes of farmed salmon for New Brunswick were estimated at $6.40 per kg once the farm is at full production (as reported in the above mentioned study of the New Brunswick industry). In that same study, prices for Atlantic salmon are estimated at approximately $13 per kg which gave some cushion for prices to drop if markets were to deteriorate. In 1989 salmon prices dropped to between $8.00 and $9.00 per kg. but they have somewhat recovered to some $11.00 per kg. as prices worldwide seem to have stabilized. Nevertheless, profit margins have been eroded particularly since interest costs have increased.

Expertise and Infrastructure

The industry in Eastern Canada has a well-trained labour force, a large pool of research scientists and an extensive network of hatcheries and other organizations supplying the industry:

- There are a number of large companies which have processed, marketed, and distributed fish products from the wild fisheries and are now taking an active part in aquaculture.
- A number of small to medium size growers in New Brunswick have formed a cooperative, Atlantic Silver Ltd., to market their production.
- The Atlantic provinces have widespread technical and industry knowledge in hatchery and related fields.

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[2]Economic Assessment of Salmonoid Cage Culture Industry in Southwestern New Brunswick, prepared by Flander-Good Associates Ltd. in association with Washburn & Gillis Associates Ltd. on behalf of the Federal Department of Fisheries and Oceans and the Government of New Brunswick, March 31, 1988.

- The St. Andrews biological station and demonstration farm continue to play a major role in providing technical advice and support to the industry. Other institutions including community colleges and government departments have also developed related training courses.

Government Regulations

The industry in Eastern Canada is subject to environmental regulations which are comparable with those in B.C., Norway and Scotland. In addition, the industry in Eastern Canada was subject to a number of other limiting regulations such as the New Brunswick and Quebec moratoriums on future salmon farming sites in those regions. These regulations allowed the orderly development of the industry in contrast with the B.C. salmon farming sector which was allowed to grow at a much faster rate. As a result, farms in Eastern Canada were, on average, relatively more established than those in B.C. when the industry was hit by declining world salmon prices in 1989.

Outlook to the Year 2000

This section projects the size of the salmon farming industry in Atlantic Canada under three sets of assumptions, namely, high, moderate and low industry growth. Because of the diversity of the various provinces, projections have also been developed for each province whenever possible. These projections are presented in the table following and are described in the following paragraphs.

TABLE 12

Outlook to the Year 2000

Eastern Canada Salmon Farming Industry[1]

	Production(MT)		Number of Sites		Full-time Equivalent Employment[2]	
	1995	2000	1995	2000	1995	2000
New Brunswick:						
High	10,000	12,000	75	75	450	450
Medium	8,500	10,000	60	60	360	360
Low [3]	7,000	8,000	45	45	270	270
Nova Scotia:						
High	1,000	2,000	10	20	50	100
Medium	600	1,000	5	10	25	50
Low	300	500	5	5	25	25
Quebec/P.E.I. Newfoundland/:						
High	1,000	1,500	4	5	40	50
Medium	500	1,000	3	4	30	40
Low	300	500	2	2	20	20
Total Eastern Canada:						
High	12,000	15,500	89	100	540	600
Medium	9,600	12,000	68	74	415	450
Low	7,600	9,000	52	52	315	315

Notes:

(1) These projections assume that the current technology of net pens operating in sea waters continue to be the most prevalent technology used in salmon farming. Technological changes and the widespread adoption of land based systems could result in much higher production projections.

(2) Excludes employment at hatcheries and processing plants; represents full-time equivalent positions. Due to seasonal and part-time employment, the number of individuals involved in the industry may be much higher.

(3) It is probable that these estimates will be exceeded by 1991. Should this occur, it seems reasonable to expect that high growth estimates will be achieved by New Brunswick salmon farming industry.

High Growth Scenario

The province which shows the most potential for growth is New Brunswick, followed by Nova Scotia, Quebec, P.E.I. and Newfoundland. Under high growth assumptions, Eastern Canada is estimated to produce 15,500 MT of farmed salmon by the year 2000, with about 12,000 MT coming from New Brunswick, 2,000 MT coming from Nova Scotia and another 1,500 being produced in land based facilities in Quebec, P.E.I. and Newfoundland.

These projections assume that the current technology of net pens operating in sea waters will continue to be the most prevalent technology used in salmon farming. Technological changes and the widespread adoption of land-based and other systems could result in higher than projected growth throughout Eastern Canada. Land-based systems are technically feasible, but their viability has yet to be established. The attractiveness of land-based systems relative to sea cages will be determined over the next three to five years.

If the profitability of land-based techniques materializes, proximity to markets could become one of the determining factors in location decisions. Eastern Canada has a distinct advantage over Norway, B.C., Chile and other producing countries in supplying the Quebec, Ontario and eastern U.S. markets. Eastern Canada, however, is at a disadvantage relative to B.C. and the U.S. Northwest in supplying Japan, one of the larger potential markets.

The following paragraphs review the projections on a provincial basis.

New Brunswick:

Industry growth in New Brunswick is expected to be limited by the number of sites which are suitable for salmon farming production in sea cages. Existing salmon farms are concentrated in one small area near Passamaquoddy Bay in the Bay of Fundy. The maximum number of potential sites in that region is estimated by industry and local governments to be around 75, compared to the 49 existing operating sites.

Assuming that New Brunswick can sustain about 75 operating sites for cage operations, farmed salmon production in that province will reach as much as 10,000 MT of farmed Atlantic salmon by 1995, or more than double the 1989 production of 4,250 MT. By the year 2000, production is expected to increase to about 12,000 as the 75 operating farms reach capacity (assumed to range between 150 and 200 MT).

Under this scenario, employment at the fish farms will increase to the equivalent of 450 full-time persons or about six employees per farm. This is slightly higher than the average employment of five employees per farm estimated for the industry in 1988 in order to account for the larger farm capacity.

These production projections assume that by the year 1995, only about half of the farms will be operating at full capacity with the other half producing at about 50% of available capacity. Thus, in 1995 the industry will have a production capacity of about 13,000 MT (75 sites of 175 MT per site) yet production will be around 75% of this capacity at 10,000 MT.

For New Brunswick to reach this production level, there are a number of other conditions which will have to be met:

- This scenario assumes that prices for salmon will increase from existing levels over the next five years to stimulate further investment in the industry. World supplies for salmon are expected to increase significantly by the year 2000; this scenario assumes that the demand for fish will increase to meet the supply and that prices will improve through to the year 1995.
- The production of farmed salmon in New Brunswick will have to prove feasible on a long term basis for all 75 sites. This scenario assumes that industry will not be impacted by a severely cold winter which could kill a large percentage of the salmon stock and deter future investments particularly in some of the less attractive sites.
- Lastly, these projections assume that industry will succeed in obtaining capital during the next few years. This is a plausible assumption provided that the existing operations continue to prove to be profitable and particularly if interest rates drop from current levels.

Nova Scotia:

There are currently eighteen marine sites in Nova Scotia: eight grow both marine rainbow trout as well as salmon while the other ten only grow marine trout. There is one land-based farm which is operating although production results in 1989/90 have been somewhat disappointing and another which recently shutdown.

Marine fin-fish farms in Nova Scotia produced 145 MT of farmed salmon in 1989 (excluding about 184 MT of farmed rainbow trout). As mentioned earlier, production in Nova Scotia in 1989 was lower than initially anticipated due to higher than expected mortality rates and other production and marketing problems. Because of the production setbacks experienced in 1989 and the last few years as well as relatively low salmon prices, the industry is likely to be cautious over the next five years. Even under a high growth scenario, the industry in Nova Scotia is unlikely to reach a production level which is much higher than 1,000 MT by 1995.

Conditions which will be required for Nova Scotia to reach this production level within the next five years include:

- Somewhat improved prices and stable production costs.
- Relatively mild winters at least initially such that existing producers do not suffer significant losses.
- Ability for new entrants to obtain financing and for existing farms to remain in operation.

Provided that the 1,000 MT production level is reached by 1995, Nova Scotia will potentially double this production level by the year 2000. This projection is based on the following assumptions:

- Prices will remain stable beyond 1995 and through to the year 2000, so as to encourage investments in salmon farming in that province. Because of the investment required beyond 1995 to achieve the 2,000 MT level, the high growth scenario for Nova Scotia is more dependent on prices than for New Brunswick, where the bulk of investments will be made in the early 1990's.
- Profitability in the industry will materialize by 1995 which will encourage investment in the industry.
- Operating costs in the industry, particularly those relating to feed and labour, will remain somewhat constant.

The number of operating sites required to achieve these production levels depends on the holding capacity per site. As mentioned earlier, there are eight sites that grow salmon in sea cages and another ten that grow marine rainbow trout but could potentially grow salmon given the right market conditions. A high growth estimate is for the number of sites which primarily grow salmon to increase to 10 by 1995 and 20 by 2000. This is based on the following assumptions:

- 140 MT holding capacity, or about the same size as was prevalent in New Brunswick in 1988, when the industry in that province was still fairly new.
- a 75% utilization rate based on half the farms operating at capacity and the other half operating at about half of total capacity.

Farm-related full-time equivalent employment resulting from these production levels would be 50 by 1995 and 100 by the year 2000 based on an average of five employees per farm.

Quebec/Newfoundland/P.E.I.:

Salmon farming in Quebec and P.E.I. is limited to land-based facilities because of cold water temperatures and icy conditions in the winter.

The same holds true for Newfoundland except perhaps in the Bay d'Espoir area where there are experiments underway regarding rearing salmon in sea cages.

There are limited opportunities for each of these provinces to expand the salmon farming industry, primarily because land based facilities are capital intensive and their economic feasibility is still questionable.

Given these limitations, the development of salmon farming in these locations will be on a selected basis, as is the case now with the farms in Bay des Chaleurs and in Georgetown, P.E.I. Under high growth assumptions, production of farmed salmon from these regions is expected to reach 1,000 MT by 1995 and 1,500 MT by the year 2000. Through to the year 1995, the facilities similar to those in Georgetown, P.E.I. and the Bay des Chaleurs are likely to produce the majority of the salmon production and the number of sites is expected to be around five:

- There are no other major land based facilities being built in these provinces. Given the time lag for land based facilities to reach full production, production from new facilities will not be significant over the next few years.
- The viability of salmon farming in Quebec, apart from Bay des Chaleurs, has not yet been established.
- The facility in P.E.I. was largely funded by governments; further public sector investments will probably depend on the success of the operation in Georgetown, especially since the farm is now in receivership for the second time in two years. Financial and operating results have also been disappointing at the land-based farm in the Bay des Chaleurs.

Provided that these facilities prove profitable by 1995, there will likely be further investment in other land based facilities. Under these conditions, production could increase to 1,500 MT by the year 2000 with the number of sites increasing to about five.

Employment from these facilities by the year 2000 is expected to be about 50 full-time positions or ten full-time employees per site. This is about twice the average employment per site in other provinces as sites will be land based and thus potentially larger.

Low Growth Scenario

Under low growth assumptions, farmed salmon production from Eastern Canada will increase to 7,600 MT by 1995 and about 9,000 MT by the year 2000, or about double the 1989 production level. Under this scenario, the bulk of the production will originate from New Brunswick with Nova Scotia, Quebec, P.E.I. and Newfoundland producing insignificant amounts:

- The total number of sites in New Brunswick may remain around 45-50 sites, particularly if some of the existing sites prove unsuitable for salmon production in the long run.
- One or more of the land based operations in Georgetown, Quebec and Nova Scotia may shutdown if proved unprofitable. Alternatively, these operations may select to rear only marine rainbow trout depending on market conditions. The cost of raising trout is lower than salmon as trout can sustain much higher densities, a factor which also reduces the cost of producing the smolts.
- Attempts to grow smolts and salmon in Newfoundland may fail.

It is probable that New Brunswick salmon production could reach low growth estimates (7,000 - 8,000 MT) by 1991. If this occurs, it seems likely that the industry will grow according to the high growth scenario presented in this report, reaching 12,000 MT by the year 2000.

Medium Growth Scenario

A middle-of-the-road projection is for the Eastern provinces to reach a production level of about 9,600 MT by 1995 and 12,000 MT by the year 2000. Of the 12,000 MT produced in the year 2000, about 10,000 MT will be produced in New Brunswick, 1,000 in Nova Scotia and 1,000 MT in the other three provinces.

This scenario presents a midpoint between the high and low growth scenarios, as summarized below:

- The number of operating sites in New Brunswick will increase to 60 from some 40 to 45 existing sites. As mentioned earlier, the major constraint here will be the number of suitable available sites in the small area near Passamaquoddy Bay.

- Production in Nova Scotia will increase to 1,000 MT by the year 2000 and the number of operating sites which grow primarily salmon will be about five in 1995 and ten in the year 2000. However, there may be a larger number of sites growing a combination of salmon and marine trout. As mentioned earlier, Nova Scotia reports eight sites which grow salmon in combination with marine rainbow trout and another ten which grow only marine rainbow trout.

- The land based facilities in P.E.I., Quebec and Nova Scotia will continue to operate but further investments in other land based facilities would be limited. Under these conditions, production will reach 500 MT by 1995 and 1,000 MT by the year 2000. This scenario accounts for one other land based site to be built in Quebec, P.E.I. or Newfoundland by 1995 and another two by the year 2000.

Conclusion

In conclusion, the salmon industry in Eastern Canada will probably achieve a production rate of between 9,000 MT and 15,500 MT by the year 2000 with New Brunswick accounting for about 80% of this production in the high growth scenario and about 90% under low growth assumptions. The number of sites operating in Eastern Canada is expected to range between about 50 and 100 and direct employment is likely to be between about 315 and 600. This represents full-time equivalent employment and it excludes indirect employment which will result from hatcheries, equipment manufacturers and other suppliers to the industry.

These projections are about the same as what we expected in late 1988. We have revised the production projections upward for New Brunswick, given the success of farms in that region, (farms in New Brunswick have increased production from 1,315 MT in 1987 to over 3,000 MT in 1988 and

4,250 MT in 1989). The production projections for the other provinces have been reduced slightly reflecting the production problems experienced in Nova Scotia, and at land based facilities in P.E.I. and Quebec.

Chapter 3 - The Oyster Industry in B.C.

Historical Development in the Pacific Oyster Industry

The culture of Pacific oysters in British Columbia started at the beginning of the century when the Pacific oyster was imported from Japan for cultivation. However, little cultivation of Pacific oysters took place until the native B.C. oyster stocks were depleted. Commercial oyster production began in the late 1950's and peaked in 1963 at 5,900 MT.

Production of cultured oysters declined in the years following this peak harvest, reaching a low production level of 1,415 MT in 1981. This decline in production was primarily due to declining productivity in the major growing areas because of poor bottom culture practices and the reliance on natural spat nursery and wild harvest techniques.

Historical production for B.C. is presented in Table 13 on the following page.

While oyster production declined between 1977 and 1981, production increased in the 1980's, because of the development of hatcheries, the adoption of better technology for seeding and the increasing use of off-bottom production methods. This is also reflected in the increasing number of leaseholders and licenses over the period.

Off-bottom oyster culture refers to methods of growing oysters by suspending them from surface floats over deep water. The advantages of off-bottom cultures over bottom (beach) cultures include:

- Faster growth;
- Higher yields per unit of water surface area;
- Lower mortalities; and
- The production of a more visually appealing oyster.

The main disadvantage is that off-bottom methods require larger capital costs and that growers are required to remove fouling (unwanted organisms attached to the oysters) during grow-out or at harvest.

TABLE 13

B.C. Oyster Production 1977 - 1989

	Lease Holders	Issued Licences	Production (metric tonnes)	Percentage Change Increase	Value[1] ($000's)	Average Production Per Site (metric tonnes)
1977	71	177	2,998	(7)%	$ 981	16.9
1978	78	202	2,793	(7)	1,021	13.8
1979	80	208	2,231	(20)	893	10.7
1980	101	239	1,922	(14)	1,134	8.0
1981*	114	250	1,415	(26)	1,030	5.7
1982*	145	282	1,579	12	981	5.6
1983*	164	303	2,453	55	1,554	8.1
1984*	168	310	2,897	18	2,109	9.3
1985*	188	334	3,420	18	2,613	10.2
1986*	200	350	2,864	(16)	2,500	8.2
1987*	249	385	3,000	5	3,000	7.8
1988	265	437	3,701	23	2,726	8.0
1989	n/a	422	3,900	5	3,000	8.8

Notes:

N/A Not available

* Includes a small harvest of wild oysters from picking permits.

(1) wholesale value

Source: British Columbia Ministry of Agriculture and Fisheries.

The industry in B.C. operates under the controls of the B.C. Oyster Board. The Board sets minimum selling prices of domestically grown oysters and determines the allowed markup by wholesalers. The B.C. Oyster Board has no authority on import prices and B.C. producers face strong price competition from their counterparts in the United States.

B.C.'s oyster production is a small portion of total world production. The major producing countries include Japan, with a production of about 250,000 MT, and France which produces around 100,000 MT.

Constraints Facing the Industry

The industry in B.C. faces a number of constraints. These include:

- **Site Availability.** Most sites which are suitable for bottom culture have already been leased and the industry has been constrained by the lack of available sites. However, off-bottom culture methods are less dependent on the characteristics of the foreshore ocean bottom and they offer considerable opportunities for development. The potential for the industry has also been hampered by small family operations, lack of a business approach and lack of property control over growing sites.

- **Availability of seed.** Seed oysters may come from either wild or hatchery sources. Wild seed is obtained by placing suitable collectors in waters where heavy natural sets are known to take place. Seed may also be created in hatcheries as research is continuing to improve the setting and post setting success in hatchery environments. There are four primary seed suppliers in B.C., two of which also produce larvae. These suppliers cannot meet the local demand, and most larvae and hatchery seed required by industry are imported, principally from Washington State (Coast Oyster Co.).

- **Labour costs.** Oyster farming is a labour intensive process. Hourly wages in B.C. range between six and twelve dollars per hour depending on location, but most labourers get eight to nine dollars per hour, including benefits. Although labour costs in B.C. are comparable to those in the U.S. they are substantially higher than labour costs in South East Asia. This reduces the potential for import displacement of canned oysters.

- **Pollution and diseases.** Pollution in B.C. is not as severe as in the United States but it has caused abandonment of a number of beach leases and has affected the supply of wild seed in certain areas.

- **Financing.** Most good bottom sites have been leased and the potential for industry growth will require the use of capital intensive off-bottom methods. Cash flow is also a problem as oysters typically require about two years to reach marketable size. Raised on a diet of cultured microalgae, however, the oysters can reach a size suitable for the half shell market in about nine months.

- **Markets.** Markets have not been a major constraint to growth except that B.C. producers are forced to compete with U.S. producers for local markets. This tends to exert downward pressures on prices and restrict industry profitability.

  The fact that oysters are not marketable during the summer while they spawn has sometimes hindered industry in marketing its products. Efforts are underway to produce sterile oysters or develop genetically different types of seed whose quality does not decline during the summer.

Strengths of the Industry

B.C. produces a small share of the worldwide production of oysters. Nevertheless, B.C. has certain competitive advantages, described as follows:

- Demand for oysters is increasing along with the demand for other fish and shellfish.
- As reported in a study on the marketing opportunities for the oyster industry conducted on behalf of the B.C. Ministry of Agriculture and Fisheries, opportunities exist for increasing sales volumes of fresh oysters in B.C. The Canadian per capita consumption of oysters has traditionally been half that of the U.S.
- Up until recently, the industry in B.C. has made little effort to expand B.C. or Canadian sales through advertising or consumer awareness programs. Plans are underway, however, to initiate a new marketing program with slogans, brand name advertising, etc., similar to the provision undertaken by the B.C. mushroom industry.

Outlook for the Industry in B.C.

This section projects to the year 2000 the size of the oyster industry in B.C. The projections under high growth, medium growth and low growth assumptions are presented in the table below and in the paragraphs following:

TABLE 14

Outlook to the Year 2000

B.C. Oyster Industry

	Production (MT)		Number of Sites		Employment	
	1995	2000	1995	2000	1995	2000
High growth	7,000	12,000	700	1,200	350	600
Medium growth	6,000	9,000	600	900	300	450
Low growth	5,000	6,000	500	600	250	300

High growth

Studies indicate that B.C. waters can produce 10 to 50 times the current quantity of oysters through improved on-bottom culture methods and increased use of off-bottom leases.

Although the potential is there, industry production is unlikely to reach this potential by the year 2000:

- Obtaining hatchery produced seed is still a problem - most seed oysters are imported from the U.S.; also, the setting and post-setting process is still under research and development.
- There are limited sites suitable for on-bottom culture of the oysters and thus expansion will likely be in off-bottom production. There are no records of what proportion of production is off-bottom but the industry estimates it to be around 10% of the shucked oyster market and about 40% of the half shell market.

The production of oysters in B.C. has more than doubled since 1981, increasing at an average production level of about 300 MT per year. However, increases varied widely from year to year, ranging from 5% in 1987 to 55% in 1983, for an average annual compounded rate of 13% over the eight year period from 1981 to 1989.

Thus, one scenario is for oyster production to grow at an annual rate of about 11% a year through to the year 2000, or a slightly lower rate as that experienced since 1981. Under this assumption and a 1989 oyster production of about 3,900 MT, production will reach about 7,000 MT by the year 1995 and 12,000 MT by the year 2000.

Under these production projections, the number of sites is estimated to reach 700 by 1995 and 1,200 by the year 2000. This is based on an average production of 10 MT per site, which is about a 10% increase in average production per site for 1989 as was shown on Table 15.

Under these conditions, employment in the oyster industry in B.C. will increase to 350 persons by the year 1995 and to 600 by the year 2000. This is based on an average production level of 20 MT per person per year equivalent, assuming a current production level of 3,700 MT and an estimated 225 full-time equivalent positions in the industry (about five full-time persons per site) in 1989. However, because most farms are ancillary operations, a large portion of the total employment is part-time and seasonal (e.g., students).

The achievement of this production level will require that:

- The exchange rate between Canada and the U.S. remains at the current level such that Canadian producers are at an advantage in competing in the U.S. market.
- Canadian markets expand to absorb this supply increase, or B.C. producers succeed in penetrating the U.S. markets.

- The oyster industry does not experience a major disease or contamination outbreak.
- Local competition from increased production of scallops, abalone and clams does not pose a serious threat to the industry (sites and market replacement).
- Oyster seed will remain available at or below current prices. This is a reasonable assumption as research and development in that field should reduce the cost of producing seed.
- Production costs remain sufficiently below market prices to stimulate investments. In March 1988, the B.C. Ministry of Agriculture and Fisheries estimated that prices for B.C. oysters were between 10% and 25% higher than the estimated 1988 production costs using off-bottom methods. The cost of production by off-bottom methods and average prices for B.C. oysters are reported in Table 15 following.

TABLE 15

Estimated Production Cost for Off-Bottom

Oyster Production

	1988 Cost of Production		Prices	
	Range	Average	December 1988	December 1989
Half shell ($/dozen)	$2.77-3.06	$2.83	$3.10	$3.50
Shucked Meats ($/U.S. gallon)	$21.40-$25.90	$22.44	$28.00	$33.00

Source:

Aquaculture Information Bulletin No. 21, B.C. Ministry of Agriculture and Fisheries, March 1988.

Price effective December, 1988 as reported by the B.C. Oyster Board.

Prices effective December, 1989 as reported by Canadian Aquaculture Magazine, Jan./Feb., 1990.

Low Growth Scenario

One possibility is for industry to increase production at a more modest compounded rate of say 5% a year. Under these conditions, production will increase to about 5,000 MT by 1995 and to 6,000 MT by the year 2000. Under this scenario, the number of sites will increase to 500 by the year 1995 and to

600 by the year 2000. Employment will increase to about 250 full-time equivalent positions by 1995 and to 300 by the year 2000.

Major conditions which could seriously restrict the growth of the industry are summarized below:

- The Canadian dollar may continue to increase in value relative to the American dollar which could worsen the competitive position of B.C. producers relative to their counterparts in the United States.
- The costs and availability of seed from hatcheries may restrict the growth of the industry. Any increases in seed cost will reduce the profitability of the industry and potentially limit new investments.
- Financing may be a problem, particularly since off-bottom techniques create higher capital costs.
- Markets may be a problem, although under this scenario, the projected production to the year 2000 of 6,000 MT will be about equal to the 1963 production of 5,900 MT.
- This scenario assumes that the industry will not experience a major disease outbreak or contamination which could result in much lower production levels than these projected.
- Increased competition and supply farm clam, scallop and abalone farmers will act to keep prices low.

Medium Growth Scenario

A medium growth scenario is for the B.C. oyster industry to reach a production of 6,000 MT by 1995 and 9,000 MT by the year 2000, which is about a mid point production level between the low growth and high growth scenarios. Under this assumption, the number of leases will increase to 600 by the year 1995 and 900 by the year 2000. Employment will be around 450 full-time equivalent positions by the end of the decade.

Conclusion

In conclusion, the B.C. oyster industry will likely see its production increasing to between 5,000 MT to 7,000 MT by the year 1995. The number of sites which are suitable for bottom culture is limited but with off-bottom production methods becoming more common, the industry has the potential to increase production significantly in the next decade. Major constraints to growth will be the availability of oyster seed, the ability of B.C. producers to compete with American producers in U.S. markets and increasing competition for sites and buyers from other shellfish producers.

Chapter 4 - The Oyster Industry in Eastern Canada

Historical Development of Oyster Farming in Eastern Canada

There are two major oyster species which are cultivated in the Atlantic provinces, namely the American and the Belon (European) oyster.

Summer seawater temperatures determine the spawning success and survival of the American oyster. In Eastern Canada, areas with favourable conditions include the southern Gulf of St. Lawrence and the Bras d'Or Lakes on Cape Breton Island, Northumberland Strait, and sheltered areas on the atlantic coast of Nova Scotia. Water temperatures are too cold for growing American oysters in the Bay of Fundy.

Many consider the Belon oyster an ideal candidate for culture in the oceanic waters of the Nova Scotia coast. A number of growers have established viable stocks of Belon oysters along the east coast of Nova Scotia, with commercial production established in 1988. Although the Belon oysters can be grown along the Nova Scotia coast, they cannot grow in the Bay of Fundy (too cold) or the Gulf of St. Lawrence (too warm). The occurrence of strong tides and currents in the Bay of Fundy also make it impossible to grow oysters.

Commercial oyster production in Eastern Canada is primarily in New Brunswick, Nova Scotia and P.E.I. It is virtually non-existent in Newfoundland and is just starting to develop in Quebec. 1988 and 1989 oyster production for Eastern Canada is reported in Table 16.

TABLE 16

Oyster Production in Atlantic Provinces

	Production (MT)		Number of Leases
	1988	1989	1989
New Brunswick	611	426	850
P.E.I.	1,461	1,895	1,004
Nova Scotia	140	101	220
Total	2,212	2,422	2,074

Source: Department of Fisheries and Oceans, the Nova Scotia Department of Fisheries Aquaculture and the P.E.I. Department of Fisheries and Aquaculture.

In New Brunswick and P.E.I., the majority of the leases are held by cottage sized ventures and not by commercial operations:

- In New Brunswick, while there are about 850 leases held, only about ten lease holders purchased seed for grow-out on private beds and about 75% of the oyster production came from public beds.
- In P.E.I., most oysters are harvested in the spring from public beds and moved to privately leased beds for re-harvest in the fall. Some 10% of the leases are held by active commercial operation.

Oyster production in Nova Scotia has been increasing but it is still small relative to production in other Eastern provinces. Out of the 200 or so leases, about ten operations use off-bottom methods and the balance produce bottom-cultured oysters on private beds.

Total Canadian oyster production in 1989 increased by about 9% over 1988 production. However, though production increased by 30% in P.E.I., it fell in New Brunswick and Nova Scotia.

Constraints Facing the Industry

Some of the constraints facing the industry in Eastern Canada are as follows:

- Markets for oysters have not been very strong over the last year as oysters face increasing competition from other shellfish. Marketing may become an even more important constraint as oyster production increases in Eastern Canada and elsewhere.

- Site availability is a constraint in some areas of Eastern Canada as favourable conditions are concentrated in the southern Gulf of St. Lawrence and the Bras d'Or Lakes on Cape Breton Island.

- Limited seed supply has been a major impediment to industry growth in Nova Scotia and it is still a constraint in New Brunswick.

- Limited private and government finance and lack of infrastructure.

- The long life cycle of the oyster is a problem: three to four years for the Belon oyster and six years for the American oyster.

- Because of the long life cycle of the American and Belon oysters, cash flow is often a problem. This is particularly so with current high interest rate levels.

- As mentioned earlier, commercial oyster production in Eastern Canada is limited to New Brunswick, Nova Scotia and P.E.I. Within these regions, oyster production has the potential to increase significantly such that the availability of sites which are suitable for oyster farming, is unlikely to restrict production for the next decade. Off-bottom production methods increase oyster production capabilities of the region. There are also many opportunities to produce large volumes from existing on-bottom sites, particularly in Nova Scotia.

- Lastly, recent oyster growing husbandry technology, and research and development relating to this sector has been limited. It is expected that better production techniques will foster industry growth in the future.

Strengths of the Industry

The strengths of the industry are as follows:

- The Atlantic provinces are close to the large Eastern U.S. markets. This is an important advantage for supplying the markets for fresh oysters.

- The demand for oysters in Eastern Canada has the potential to increase. The per capita consumption of oysters has traditionally been half that of the U.S. Also, the industry in Atlantic Canada has made a limited effort to expand domestic sales through advertising or consumer awareness programs.

- There is strong U.S. demand for Canadian oysters which can be stablized and strengthened through an effective marketing campaign and continued emphasis on a high quality product.

Outlook for the Industry

This section projects to the year 2000 the size of the oyster industry in Atlantic Canada, under high growth, medium growth and low growth assumptions. The projections are summarized in Table 17 and are described in the following paragraphs.

TABLE 17

Outlook to the Year 2000

Atlantic Canada Oyster Industry

	Production (MT)		Full-Time Equivalent Employment	
	1995	2000	1995	2000
High growth	5,000	7,000	250	350
Medium growth	4,000	5,000	200	250
Low growth	3,000	4,000	150	200

Note: Employment data represents full-time equivalent positions held for a full year; the number of individuals involved in the industry is much higher, may be up to five times this amount.

High Growth Scenario

There is significant potential to increase the production of oysters in Atlantic Canada. With the new hatchery in Nova Scotia, there is potential for a large number of oyster farmers to enter the industry and for existing lease holders to begin producing at higher levels. Major constraints to growth include financing, lack of infrastructure and oyster seed, and the difficulty to earn an adequate rate of return from a crop that can take as much as six years to harvest, particularly with current interest rate levels.

One possibility is for Atlantic oyster production to grow at the same, or slightly higher, compounded rate as that experienced in B.C. since 1981, or about 13% per annum at least until 1995. The two industries are not directly comparable. Oyster farming in Eastern Canada may grow faster than it did in B.C. because of the ability for Eastern Canada to supply the larger Eastern Canadian market and produce the Belon oyster, a new product in North America. On the other hand, oyster farming in Eastern Canada may grow at a slower rate than it did in B.C. because of the longer life cycle of the

Belon and American oysters relative to the Pacific oyster. This scenario assumes that these factors will balance each other such that oyster farming in the East will grow at about 13% per annum for the next five years. This growth rate is expected to slow down by about half to some 7% in the latter part of the decade as the industry matures. Much of this increase will originate in P.E.I.

Under these conditions, oyster production will reach about 5,000 MT by 1995, or about double the current production level, and about 7,000 MT by the year 2000. The achievement of this production level will require that:

- The market in Eastern Canada expands to absorb this increase in supply, or Eastern Canadian producers succeed in penetrating the U.S. and European markets. Fresh Belon oysters are not available commercially in North America, but in Europe, they are viewed as a much higher quality product than the American or the Pacific oyster. In any event, markets have been slow over the last year and the industry will have to become more marketing oriented in the years to come to achieve its potential.

- Production costs remain sufficiently below market prices to stimulate investments. Investment in the industry has increased in the last few years with the investment in the hatchery in Nova Scotia and renewed interest in the industry. Various government incentive programs may be required for investments to continue to increase over the next decade, particularly with interest rates at current levels.

- The exchange rate between Canada and the U.S. dollar is such that Canadian producers remain competitive in the U.S. market. The Canadian dollar has gained in value relative to the U.S. dollar in the last two years. However, producers reported not having suffered greatly because of the rise in the Canadian dollar because current production is primarily sold within Canada. Further increases in the Canadian dollar will make it more difficult to capture U.S. markets.

- The proportion of Belon oysters cultivated, relative to American oysters, increases significantly. Belon oysters take about three to four years to grow compared to up to six years for American oysters and between 9 and 24 months for Pacific oysters grown in B.C. Because of the longer growth cycle of American oysters, investment in farms growing American rather than Belon oysters will delay the achievement of higher production levels.

- Lastly, this scenario assumes that the oyster industry does not experience any major setback relating to diseases such as the Malpeque disease which destroyed between 90-95% of the oyster stock between 1920 and 1950. The remaining oysters became disease resistant and these form the current oyster stocks.

Employment related to oyster production in Eastern Canada is not available. In B.C., about 20 MT of oyster production translates to one full-time equivalent position. On this basis, current employment in Eastern Canada is estimated at about 120 full-time equivalent positions. With production more than doubling by the year 1995, employment is expected to increase to 250 by 1995 and to 350 full-time equivalent positions by the year 2000. However, a much larger number of people, perhaps four to five times as many, will be involved in the industry: oyster growing is typically combined with other means

of livelihood and during the start-up years of an oyster farm, there will be employment but no production.

These projected production levels may not necessarily require a larger number of leases as the majority of the leases currently issued are not used to their full potential.

Low Growth Scenario

One possibility is for production to increase at a relatively slow rate of say 5% to the year 2000. Under this assumption, production will reach 3,000 MT by 1995, and increase to 4,000 MT by the year 2000. Under this scenario, employment will increase proportionally to about 150 full-time equivalent positions by 1995 and to 200 by the year 2000.

Conditions which could restrict the growth of the industry are summarized below:

- Developing markets for the Belon oyster may prove more difficult than anticipated such that oyster prices may drop below or near production costs, thereby deterring investment.
- The hatchery in Nova Scotia may be setback by diseases, lack of financing or other factors which may limit the availability of seed to the industry.
- The Canadian dollar may continue to increase in value relative to the United States dollar which could reduce the competitive position of domestic producers of American oysters for export relative to their counterparts in the United States.
- Adequate levels of financing, particularly from the private sector, may be a continuing problem due to the fact that the Belon and American oyster take a number of years to reach market size.
- Profitability in the industry may be such that the private sector finds it unattractive to invest in a crop which takes as much as six years to harvest.

Medium Growth Scenario

One alternative is for the oyster industry in Eastern Canada to reach a production of 4,000 MT by 1995 and 5,000 MT by the year 2000. Under this assumption, employment will be around 200 full-time equivalent positions by 1995 and about 250 by the year 2000.

Conclusion

In conclusion, the oyster industry in Eastern Canada will likely see its production levels increasing to between 4,000 MT to 7,000 MT by the year 2000 providing between 200 and 350 full-time equivalent positions. Major constraints to growth include the ability of the industry to develop new markets, adequate private sector financing, particularly if interest rates remain at their current high level, and the availability of oyster seed.

Chapter 5 - The Blue Mussel Farming Industry

Historical Development

Virtually all of the blue mussel supply in Canada is produced in the Atlantic region with a very limited supply coming from British Columbia. Mussel production in Atlantic Canada and B.C. is shown in Table 18. Estimates of mussel production for Atlantic Canada vary depending on the source of information. The data presented in this chapter are based on statistics published by the P.E.I. government and the Department of Fisheries and Oceans.

In 1988, Prince Edward Island accounted for 70% of the total Canadian production of blue mussels, Nova Scotia accounted for 16%, Newfoundland and Quebec 9%, New Brunswick 5%, and B.C. produced an insignificant amount. Virtually all mussel production in Canada is from cultivated stocks rather than wild stocks. Table 18 also shows that the industry in P.E.I. went from producing 12 MT in 1978 to producing an estimated 1,441 MT in 1988 and 2,682 MT in 1989. Data represent actual shipments from processing plants. Mussel production in the water may be higher because of inventories, and a certain portion of the landings at the plant being judged non-marketable.

Mussel production increased in 1989 despite a health alert in 1988 on mussel cultivation after mussel-related illnesses were reported. While markets have fully recovered from the 1988 health alert and related negative publicity, many growers are still carrying losses incurred during that period.

TABLE 18

Production of Blue Mussels
(metric tonnes)

Production in P.E.I.

1978	12	1984	285
1979	14	1985	465
1980	49	1986	1,220
1981	47	1987	1,035
1982	70	1988	1,441
1983	163	1989	2,682

Production by Province

	1987	1988
Prince Edward Island	1,035	1,441
Nova Scotia	257	321
Newfoundland	80	80
Quebec	80	92
New Brunswick	10	111
British Columbia	2	2
	1,464	2,047

Notes:

Estimates of historical mussel production for Atlantic Canada vary depending on the source of information. The data presented in this table are based on discussions with the P.E.I. Government and the Department of Fisheries and Oceans.

Sources:

P.E.I. Department of Fisheries and Department of Fisheries and Oceans.

Neil Bourne, 'Potential for Mollusc Culture in the Northeast Pacific', Aquaculture International Congress Proceedings, Vancouver, B.C., 1988.

Gérald Arsenault, 'A Broad Outlook on the Blue Mussel Supply Worldwide'. Aquaculture International Congress Proceedings, Vancouver, B.C., 1988.

Worldwide production of blue mussels is estimated at some 850,000 MT, which represents about 80-85% of the total world mussel catch of all mussel species. Major producing countries include France, the Netherlands, Spain, Denmark, and West Germany which together produce about half of worldwide production. Other producing countries include China, Thailand, and Korea.

The mussels produced in Canada are typically sold fresh. In the fresh market, Canadian blue mussel producers compete primarily with the U.S. which in 1989 produced about 26,000 MT compared to 19,000 MT in 1988. As is the case in Canada, the bulk of U.S. production originates in the Atlantic Coast with the Pacific Northwest producing negligible amounts. The operations in New England utilize bottom culture operations which produce an inferior semi-cultivated product. Poor quality in a mussel includes embedded pearls, low meat yield, discoloured meat, and sand or silt in the body cavity.

In Eastern Canada, the blue mussel is cultivated using off-bottom techniques which result in a much higher quality product than the New England mussels. The culture process takes about 20 months and harvesting is typically done in the winter when the mussels and the markets are at their best. Harvesting is often done through the ice.

Mussel farms in Eastern Canada are very localized:

- In P.E.I., mussel farms are located in the deeper estuaries along the East side of the Island and the North side from St-Peters Bay to Malpeque Bay.
- In Nova Scotia, mussel farms are in Cape Breton and on the Eastern and Southern shores of the province.
- There are very few mussel farms in New Brunswick. The blue mussel cannot be harvested in the Bay of Fundy because of the toxic dinoflagellate which causes paralytic shellfish poisoning (PSP). There is some potential, however, for mussels to grow in the Gulf of St. Lawrence.
- In Quebec, mussel production is concentrated in the Isles-de-la-Madeleine and in the Baie des Chaleurs.
- In Newfoundland, mussel farms are located in the Northeast.
- In B.C., the blue mussel grows well throughout the province. However, commercial ventures have not proved feasible primarily because of:
  - severe diving duck predation;
  - unexplained pre-harvest mortalities in the winter; and
  - fouling by a variety of organisms including barnacles and tunicates which add to weight of the lines and require additional flotations.

The following section summarizes a number of factors which may restrict industry growth in Atlantic Canada and in B.C. over the next decade.

Constraints Facing the Industry

P.E.I. and Atlantic producers have been very successful in developing a market for cultivated blue mussels. The industry specializes in producing a premium product at a premium price. In 1988, sales distribution of P.E.I. production was estimated as follows:

TABLE 19

Sales Distribution of P.E.I. Mussels

Quebec	48%
Ontario	18%
California	14%
Maritimes	8%
Western Canada	5%
Florida	1%
Other	6%
Total	100%

Source: Gerald Arsenault, 'A Broad Outlook on the Blue Mussel Supply Worldwide'. Aquaculture International Congress Proceedings, Vancouver, B.C., 1988.

More recent data are not readily available but based on discussions with mussel growers, the majority of blue mussels continue to be sold in Quebec and Ontario. However, the U.S. markets have been growing faster than Canadian markets, and a larger proportion of the 1989 production has been absorbed by U.S. markets.

The Atlantic blue mussel industry competes in the Canadian and U.S. markets against the semi-cultivated mussel produced in the U.S. About 65% of the Canadian mussel consumption is supplied by U.S. wild and semi-cultivated mussels. Canadian cultured mussels are superior in quality over the semi-cultivated U.S. product but prices are higher. An important part of ensuring markets for the Canadian blue mussels therefore relies on promoting and convincing consumers of the superiority of the cultivated product. To date, some promotion has been conducted by the P.E.I. Development Agency.

The market potential for blue mussels is difficult to assess because of its dependence on promotion and advertising. A recent DFO market study estimates that the supply of mussels will exceed demand during 1990. If this occurs, marketing constraints will seriously restrict the growth of the industry. In 1989, mussels prices to growers dropped by about $0.05 per pound (about 10%) indicating some softening in the market for mussels.

Other constraints which may limit industry growth in Eastern Canada are as follows:

- **Financing**. With interest rates at current levels, mussel growers throughout Eastern Canada are experiencing some financing difficulties, particularly since prices softened in 1989. Based on discussions with industry, growers are currently restricting production, a fact which will impact volumes of marketable mussels in 1991.

- **Production costs and profitability**. The production of cultivated mussels is a relatively costly labour intensive process. Transportation costs are also fairly high ranging around 20% of delivered costs to Montreal and Toronto. Mussels sell for between $1.90 and $2.20 per kilo (wholesale price including delivery and processing), which according to industry sources is not significant when the production, transportation, and marketing costs are taken into account.

- **Site availability**. Most of the leases available in P.E.I. have been allocated. However, there are a number of other sites in Atlantic Canada that are suitable for mussel production.

- **Production**. There is some concern that the industry in P.E.I. has been exceeding the carrying capacity of the estuaries and that this may ultimately affect seed supply, food abundance and mussel survival rates. This is not yet a problem and it will not be a concern in other provinces for sometime to come.

- **Growth cycle**. The growth cycle of 18 to 24 months for mussels is a constraint to industry growth particularly as it relates to financing during start-up. This also restricts the industry's ability to respond to changes in markets and other conditions.

- **Pollution and contamination**. Industry faces the risk of contamination, and resultant fishery closures. An incident in December 1987 is only one example of this. In attempting to guard against this, industry and governments are always improving on tests and safeguards.

In B.C., the problems faced by mussel growers are related to production rather than markets or management. As described in a paper by Neil Bourne of the Pacific Biological Station, in B.C., titled 'Potential for Mollusc Culture in the Northeast Pacific', the major problems facing mussel culture in B.C. include:

- **Fouling by a variety of organisms including barnacles and tunicates**. These add to the weight of the lines, require additional floatation and cause processing difficulties.

- **Duck predation**. B.C. is a wintering area for several species of ducks. Duck predation can be controlled by placing nets around growing lines but this adds to costs. Scaring ducks through discharging guns is usually not allowed because of pressure from local residents.

- **Unexplained summer mortality rates as high as 80%.** Studies indicate that mortalities are probably due to physiological stress rather than disease as there appears to be a genetic component to the growth and survival of different strains of mussels. Further studies are required to determine the exact cause and solve these high mortality rates.

Strengths of the Industry

The strengths of the industry in Atlantic Canada include:

- **Seed supply.** A major advantage in mussel culture is the abundance of natural seed which can be gathered by using collectors or simply scraping mussel seed from rock walls at low tide.

- **High quality product.** The cultivated mussel is a higher quality product than the wild and semi-cultivated mussel. This provides an opportunity to displace Canadian imports of wild and semi-cultivated mussels and penetrate U.S. markets with what is essentially a new product.

- **Government regulations.** Regulations in P.E.I. and, more recently, in other Atlantic provinces, have fostered the growth in the industry. In P.E.I. and New Brunswick, a prospective grower can get a Conditional Permit which will allow him to farm a chosen site for two years before he has to negotiate surveys and pay for his lease.

Outlook for the Industry

This section projects the size of the mussel industry in Eastern Canada, as well as in B.C., to the year 2000. The projections under high, medium and low growth assumptions are presented in the table below and in the paragraphs following.

TABLE 20

Outlook to the Year 2000

Mussel Industry

	Production (MT)		Full-time Equivalent Employment	
	1995	2000	1995	2000
British Columbia:				
High growth	10	200	-	20
Medium growth	-	100	-	10
Low growth	-	-	-	-
Atlantic Canada:				
High growth	5,000	7,000	330	450
Medium growth	4,300	5,500	280	350
Low growth	3,500	4,300	230	280

High growth

Over the next decade, the growth potential for the mussel industry in Atlantic Canada will depend on the industry's ability to develop markets and maintain prices at or above current levels. Even if the number of sites in P.E.I. and the production capacity of that province prove to be limited, there are enough sites in other Atlantic provinces to allow the industry to develop provided that markets exist.

One possibility is for industry production in Atlantic Canada to increase from about 2,000 MT in 1988 and over 3,000 MT in 1989 to about 5,000 MT in 1995 and 7,000 MT by the year 2000. This translates to an annual compounded rate of about 12% between 1989 and 1995 and about 7% between 1995 and the year 2000. Expressed in percentage terms this rate is only a fraction of the 60% annual compounded rate experienced in P.E.I. between 1978 and 1988 when the production increased from about 10 MT to some 1,500 MT.

In terms of absolute production figures, however, the assumed growth is fairly optimistic. The industry in Atlantic Canada achieved shipments of 1,500 MT in about ten years of production or an increase of about 150 MT per year. This high growth scenario estimates that industry will increase production by about 400 MT per year or about 2,500 MT by 1995 and by a further 2,000 MT, five years later.

The achievement of this production level will require that:

- Prices remain around existing levels. Industry must expand demand in order to increase the supply of mussels.
- Interest rates drop sufficiently to encourage growers to increase production again. As mentioned earlier, in the light of current prices and interest rates, many growers are currently restricting production, a fact which will impact the 1991 volumes of marketable products.
- Other production costs remain stable.
- The mussel industry does not experience a major disease or contamination.

Full-time equivalent positions may be estimated based on the following assumptions:

- A labour cost component of about 40% of the wholesale value of production at the processing plant.
- A wholesale price of about $1.00 per pound or $2.2/kg.
- An average labour cost of $8.00 per hour.
- An average number of 1,500 hours worked per full-time equivalent position (or about 30 hours per week for 50 weeks).

This translates to about 15 MT per full-time equivalent position, and an employment level of about 200 in 1990. On this basis, a production level of 5,000 MT by 1995 will translate to about 330 full-time equivalent positions throughout the Atlantic provinces. By the year 2000, employment will increase to over 450 full-time equivalent positions, provided that a production of 7,000 MT is achieved. The number of growers and people involved in the industry may be up to five times this much, however, since growing mussels is usually combined with other fisheries and means of income.

Estimating the number of sites and growers required to meet this production level is difficult given the high number of leases that are currently under-utilized.

The situation in B.C. is quite different than in Eastern Canada. The major constraint to the industry in B.C. is the mortality problem. With little progress having been made to solve this problem in the last two years, it is unlikely that a solution will be found before 1995. A high growth scenario for the B.C. industry assumes that this problem will be solved around 1995, thereby giving the chance for the establishment of commercial operations.

Under this assumption, industry will continue to produce very little until 1995. After that time, the industry could be expected to duplicate the growth experienced in the first five years in P.E.I. when mussel shipments increased from about 12 MT in 1978 to 163 MT in 1983. On that basis, B.C. will

potentially reach around 200 MT in mussel production by the year 2000. This also assumes that B.C. will be cost competitive with P.E.I. and the Atlantic provinces. For this to happen, the cost of dealing with fouling and duck predation will have to be lower than the transportation cost between Eastern Canada and the markets to be served by B.C. producers. Also, labour and other costs will have to be lower or equal to those in the Atlantic provinces.

Low growth

One possibility is for the Canadian mussel industry to grow fairly slowly over the next ten years, with production increasing from 3,000 MT in 1989 to 3,500 MT by 1995 and to 4,300 MT by the year 2000:

- P.E.I. production may plateau in the near future as a result of site restrictions, marketing and/or biological constraints.
- The industry in Quebec may increase fairly slowly given that mussels grow only in the Isles-de-la-Madeleine and the Baie des Chaleurs.
- Increases in mussel production in New Brunswick, Nova Scotia and Newfoundland may not materialize:
  - The profitability of the industry may be reduced through lower prices or increased production costs, thereby limiting new investment in the industry,
  - Sites in these provinces may not prove to be as suitable to mussel production as is currently anticipated.
- Mussel growers in B.C. may continue to be plagued with heavy summer mortality rates, fouling by barnacles and tunicates as well as duck predation, such that commercial production remains uneconomical.

Under this scenario, employment will also increase more slowly, perhaps reaching 280 full-time equivalent positions by the year 2000, with all of it being in Atlantic Canada.

Medium growth

One possibility is for mussel production to reach 4,300 MT by 1995 and 5,500 MT by the year 2000. Under this assumption, employment in Eastern Canada will be around 280 full-time equivalent positions by 1995 and about 350 by the year 2000, based on about 15 MT per full-time equivalent job. Employment in B.C. will be minimal perhaps around ten full-time equivalent positions by the year 2000.

Conclusion

In conclusion, the mussel industry is well established in P.E.I. and the Atlantic provinces. Production in these provinces is expected to be between 4,300 and 7,000 MT by the year 2000. It is expected that, at maximum growth, the industry will provide 450 full-time equivalent positions by the year 2,000. In B.C. the mussel industry will either remain at an infancy stage, and continue to produce less than 5 MT annually, or it will begin to operate as a viable industry which could produce up to around 200 MT by the year 2000.

Chapter 6 - Trout Farming

Historical Development

Trout farming in Canada started more than 100 years ago primarily in the form of freshwater hatcheries established by governments and industry for resource enhancement purposes. The production and sale of trout for human consumption started on a commercial basis about 30 years ago in Ontario and the industry has made inroads in all provinces to varying degrees since that time. Trout farming in Canada has been primarily in fresh water but with the growth of marine culture, industry has been rearing marine trout in sea cages, primarily in Nova Scotia.

Rainbow trout is the primary species of fish raised on Canadian freshwater fish farms. The following chapter is concerned with rainbow trout only and does not deal with other species which comprise a very small proportion of total trout production. The species has been bred and reared for many decades and is now a domesticated fish with a rapid rate of growth, high resistance to disease, and a good tolerance to crowding.

The production of trout in Canada serves three major markets:

- Pond fishing - which in Quebec alone accounts for about 60% of the total trout production.
- Lake and river stocking.
- Human food consumption.

This chapter focuses on the production and potential for trout farming for the food market. In that market, Ontario is the leading Canadian freshwater trout producer with rainbow trout production totalling about 1,800 MT in 1988 and some 1,900 MT in 1989. Together, the other provinces produced about 500 MT of freshwater rainbow trout, excluding about 600 MT of marine rainbow trout production in 1989: 300 MT in B.C., 184 MT in Nova Scotia and another 100 MT in other Atlantic provinces. Trout production in Canada is presented in Table 21.

TABLE 21

Historical Production of Freshwater Trout[1]
(metric tonnes)

	B.C.	Ontario	Quebec[2]	Atlantic Canada[3]
1970	n/a	91	n/a	n/a
1975	n/a	136	n/a	n/a
1977	58	n/a	n/a	n/a
1978	54	n/a	n/a	n/a
1979	53	n/a	n/a	n/a
1980	56	408	n/a	83
1981	71	454	n/a	86
1982	74	540	n/a	105
1983	77	499	n/a	148
1984	71	499	n/a	109
1985	83	544	n/a	96
1986	101	1,134	n/a	111
1987	115	1,451	130	150 *
1988	115 *	1,814	250	150 *
1989	125 *	1,925	260 *	150 *

Notes:

* estimated

n/a not available

(1) Excludes marine trout production estimated at about 184 MT for Nova Scotia in 1989, another 100 MT in other Atlantic provinces and about 300 MT for B.C.

(2) Figures provided by the Quebec Ministry of Agriculture.

(3) Estimates for 1987, 1988 and 1989 are conservative, given that 1989 production in P.E.I. alone reached 70-75 MT.

Source:

Discussions with industry sources.

Commercial Aquaculture in Canada, Department of Fisheries and Oceans, 1988

Moccia, R.D., Aquaculture Extension Centre, University of Guelph, Unpublished information.

Blum H. 1979, Fish Farming in Ontario - an industry study, Ontario Ministry of Agriculture and Food.

Aiken, D.E., Status of Aquaculture in Atlantic Canada, Aquaculture Association of Canada Bulletin, Edition 87-1.

The production of freshwater trout in Ontario has grown from about 100 MT in the early 1970's to about 500 MT by 1984 and 1,925 MT by 1989. The growth in production has been more stable in B.C., increasing by smaller amounts each year. Trout production for human consumption in Quebec almost doubled between 1987 and 1988 to about 250 MT but it remained relatively stable in 1989. In Atlantic Canada, the production of freshwater trout is estimated at about 150 MT in 1989. This excludes maritime trout production for 1989 of 184 MT in Nova Scotia, about 100 MT in other Atlantic provinces and some 300 MT in B.C.

Trout farming in the prairies is fairly limited relative to other provinces. The industry in Alberta, Saskatchewan and Manitoba is dominated by hobby farms and private fish growers who purchase fingerlings (fish between 5 and 10 cm in length) and raise them in private ponds through the summer months.

Trout farming in the Territories is currently restricted to lake enhancement purposes. There is a growing interest in rearing trout for human consumption but no actual production.

Freshwater Trout Production in Other Countries

Production of freshwater rainbow trout in 1989 in the major producing countries around the world were as follows: Italy (32,000 MT), Denmark (30,000 MT), France (20,000 MT), the United States (22,000 MT), and Japan (between 15,000 MT and 20,000 MT).

Approximately 70% of the U.S. freshwater trout production is from Idaho. This province has an exceptional supply of fresh water from what is referred to as the 'Snake River Plains Aquifer'. In Idaho, Clear Springs Trout Company, has grown to become the largest producer of fish in the U.S.A. Being on the banks of the Snake river, it benefits from underground lakes which form each year from the area's snow and rain precipitation (the water eventually surfaces to form springs that pour through fissures of the rock). Production of rainbow trout from Clear Springs Trout Company for 1989 is expected to be about 8,000 MT. The company employs about 350 people, including some 200 at the farm's processing plant, about 75 engaged in raising the fish and about 75 in supporting positions. Clear Springs Trout produces about half the farm raised rainbow trout in Idaho (estimated at about 16,000 MT for 1989) and about 35% of the U.S. production expected for 1989 (about 22,000 MT).

Constraints Facing the Industry

There are a number of constraints facing the trout farming industry in Canada. These are reviewed in a number of areas, namely:

- Markets;
- Production costs and profitability;
- Site availability; and
- Financing.

Markets

In 1988, Canada imported 1,056 MT of trout including 272 MT of fresh trout, 678 MT of frozen trout and another 106 MT of fresh and frozen fillets, as demonstrated in Table 22 following.

TABLE 22

Imports of Rainbow Trout in Canada
(metric tonnes)

	Trout Imports (Canada)				Trout Imports by Province			
	Whole Fresh	Whole Frozen	Fresh and Frozen Fillets	Total	Ontario	Quebec	B.C.	Other Provinces
1981	227	586	384	1,197	n/a	n/a	210	n/a
1982	171	595	63	829	n/a	n/a	112	n/a
1983	159	543	57	759	n/a	n/a	97	n/a
1984	170	567	242	979	628	154	120	77
1985	236	206	409	851	548	79	146	78
1986	296	313	416	1,025	647	113	156	109
1987	252	540	270	1,062	602	150	192	118
1988	272	678	106	1,056	582	99	282	93

n/a - not available

Source: Statistics Canada

Table 22 also shows that imports have remained at around 1,000 MT since 1981, despite the growth in trout production in Canada of over 1,500 MT during that same period. This is largely because Canadian products do not compete directly with imports. Canadian trout are sold fresh with increasing amounts being sold smoked or as filets rather than pan-sized. The majority of imported trout from Idaho are sold frozen, at an average weight of about 250 g and for a lower price than Canadian products.

Because Canadian trout can be sold fresh all year round, the potential to displace imports is not indicative of total market size. Moreover, as is the case for other fish products, there has been little advertising and promotion directed at the consumer market.

Although the market for freshwater trout in Canada has the potential to expand, it does need to be developed. Accordingly, there are likely to be some limitations regarding market growth in the future.

Opportunities for export are likely to be limited except perhaps to the U.S. Northeast. However, there is likely to be increased competition from states like Montana which are starting to look at trout farming with interest.

Production Costs and Profitability

Trout farming yields modest returns which are comparable to those earned in other agricultural ventures. However the risks associated with trout farming are somewhat larger and the modest returns may limit investment and thus industry growth in the future.

There have been a number of studies in Quebec and in Ontario which have investigated the viability of growing freshwater trout:

- In Ontario, a review conducted by the provincial government suggested that 'the return to trout farming was modest in view of the investment costs and risks associated with trout production in Ontario'. In that report, the average revenue per kg of fish produced for a 22,700 kg operation (50,000 pounds) was estimated at $5.13 per kg. This compared with variable and fixed expenses of $4.31 per kg before considering the salary level of the owner operator but after interest expenses assuming 70% debt. This model farm was intended to be of sufficient size to allow the owner operator to obtain his livelihood from the farm which was estimated at $18,500 a year.

- A 1987 study of trout fish farming in Quebec indicated that the industry is less profitable in Quebec than in Ontario. According to that study, trout farmers in Quebec earn, before taxes, an average net return on equity of 9.8% and a return on assets of 5.8%. The survey also determined that the most profitable operations were those oriented towards the growing of fingerlings and hatcheries rather than grow-out farms. The study pointed out that these returns

could be considered to be minimum values. Nevertheless, the results showed that trout farming seemed less profitable than other agricultural ventures.[1]

Although these studies indicate that trout farming does not yield very attractive returns, the feasibility of trout farming is very site specific such that any study of average returns is not really meaningful. Moreover, trout farming is often combined with other agricultural ventures like tobacco growing, which can make it more attractive, and, in many case, is a precursor of the production of other salmonids.

Financing

The growth cycle of freshwater trout is about two years. Accordingly, cash flow is a problem during start-up. In addition, financial institutions are typically reluctant to finance trout farming operations because of the risks involved and the relatively modest profitability.

Site Availability

The availability of sites for freshwater trout depends on a number of factors including:

- Availability of fresh water sources;
- Adequate flushing;
- Water temperatures;
- Proximity to markets;
- Effluent controls or limits (regulations); and
- Discrete (biological) stock polices.

The availability of fresh, high quality water may be a limiting factor for freshwater trout production depending on the region.

Natural and artificial ponds, although suitable for sport fishing are not suitable for commercial operations. Disadvantages include:

- Incidence of blue/green algae which gives the fish a bad flavour;
- Low water turnover and resulting degradation of the environment;
- The potential for diseases due to inadequate flushing;

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[1] 'Aquiculture en eau douce au Quebec: quelques resultats financiers', M. Letourneau, J.C. Michaud, et C. Bedard, Aquaculture Association of Canada, Proceedings, Quebec, 1987.

- Fluctuations in temperature;
- Difficulty in harvesting because of different sizes and lack of uniformity in the fish produced;
- Large area required per production unit; and

The production of trout in cages situated on lakes and other surface water is not considered feasible. Most lakes in Canada are too cold and are covered with ice in the winter, and too warm in the summer to be suitable to grow freshwater trout on a commercial basis. The use of surface water for fish farming also creates problems with other resource users, such as recreation and tourism. However, surface water is frequently pumped from its orgin to tanks, for fish rearing.

Because of difficulties in growing trout in ponds or in cages situated in lakes, fish farms typically raise rainbow trout in circular fish tanks which resemble large swimming pools. Rectangular raceways have become obsolete.

Fish tanks require substantial amounts of water. The quantity of water (volume per unit time) available generally restricts farm capacity. Water quality and temperature are also important factors. Polluted water typically encourages diseases. Also, although water temperature in fish tanks may be controlled, the cost of artificially heating or cooling the volumes of water required to operate a facility may be prohibitive.

The majority of commercial freshwater trout farms in Canada operate using groundwater rather than surface water. Groundwater (water taken from the head of springs, artesian wells or pumped from underground) is often better suited to trout production than surface water. Accordingly, many of the farms in Ontario, are located in south central and southwestern Ontario with many located on the Niagara escarpment where fairly large volumes of groundwater can be found. Although the majority of trout farms in Ontario use groundwater, there is increasing interest from Ontario fish farmers in pumping fresh water from the Great Lakes into fish tanks and raising fresh water trout.

Although the choice of site is important in determining the profitability of an operation, site availability is not likely to be a major constraint to growth in most parts of Canada:

- In Ontario, there are still untapped sources of groundwater and many of the existing sites could produce more if markets warrant it. There is also substantial potential for increasing production at farms planning to utilize Great Lakes water.
- In Quebec, the Abitibi area in the northwestern region has significant amounts of untapped groundwater, giving this region substantial potential for trout production.

- In Atlantic Canada (excluding P.E.I.), groundwater is in short supply, particularly in Newfoundland and New Brunswick. In these provinces, there is potential for pumping ocean water and producing marine trout in land-based systems, although initial attempts have not been successful. Recirculation technology is, however, making inroads into trout production.

- Trout production for food consumption is at a developmental stage in the prairies. From a biological standpoint, trout farming production is not limited by site availability, but rather by a lack of water.

- In B.C., the majority of trout farms are located in the Lower Mainland on private lands, but there are other sources of groundwater in other regions.

Strengths of the Industry

The trout farming industry in Canada is not as well established as in the U.S. (particularly the State of Idaho) and other countries. Some of the advantages of Canadian trout producers are outlined below:

- **Proximity to markets**. The Canadian industry can expand to serve domestic markets but limited opportunity exists for exporting trout products, except to northeast U.S.

- **Expertise and Infrastructure**. This is particularly true in Ontario, where trout farming has been an established industry for at least ten years. In other provinces, like B.C., Quebec and the Atlantic provinces, the growth of salmon aquaculture has also resulted in increased knowledge and expertise related to fish farming.

- **Availability of fingerlings**. Trout farming is an established industry in all provinces for resource enhancement purposes and for lake and river stocking. Accordingly, there are hatcheries and fingerling producers in all provinces except in certain regions of Atlantic Canada. These hatcheries can supply smolts and fingerlings to the growing trout farming industry.

- **High quality product**. The Canadian product is of high quality and it commands a higher price than imported trout from Idaho and other parts of the U.S. This allows Canadian producers to compete against Idaho producers who have lower production costs because of the extensive supply of groundwater. Idaho operations are also very capital intensive and rely on advanced technology.

Outlook for the Industry

The production and employment projections under high, medium, and low industry growth assumptions are presented in Tables 23 and 24 and are described in the paragraphs following.

TABLE 23

Trout Production Outlook to the Year 2000
(metric tonnes)

	Low Growth		Medium Growth		High Growth	
	1995	2000	1995	2000	1995	2000
Freshwater Trout						
Ontario	2,500	3,000	3,000	3,800	3,500	4,500
Quebec	500	600	700	1,000	1,000	1,500
B.C.	150	200	225	400	300	600
Atlantic Provinces	150	200	175	250	200	300
Prairies	100	100	150	250	200	400
	3,400	4,100	4,250	5,700	5,200	7,300
Marine Trout[1]						
B.C.	1,000	2,000	2,000	3,500	3,000	5,000
Atlantic Provinces	1,000	1,500	1,500	2,500	2,000	3,500
	2,000	3,500	3,500	6,000	5,000	8,500

Note:

(1) Production may be higher if trout farming is substituted for salmon farming.

TABLE 24

Trout Farming Employment Projections

to the Year 2000
(Full-Time Equivalent Employment)

	Low Growth		Medium Growth		High Growth	
	1995	2000	1995	2000	1995	2000
Freshwater Trout[1]						
Ontario	200	250	245	315	290	375
Quebec	40	50	60	90	80	125
B.C.	10	15	20	30	25	50
Atlantic Provinces	10	15	15	20	15	25
Prairies	10	10	10	20	15	30
	270	340	350	475	425	605
Marine Trout[2]						
B.C.	40	75	75	130	110	185
Atlantic Provinces	40	55	60	90	75	130
	80	130	135	220	185	315

Notes:

(1) Based on 12 MT of fresh trout production per man year.

(2) Based on 27 MT of marine trout production per man year, which is comparable to the direct employment impact estimated in salmon farming in B.C. and New Brunswick.

Data represent employment in terms of full-time equivalent jobs. Actual employment could be two to three times higher than is represented here.

High Growth Scenario - Freshwater Trout

In Canada, farming of freshwater trout is a more mature industry than the culture of other fish and molluscs. Accordingly, in comparison to the culture of salmon, oysters, mussels, and marine rainbow trout, the growth potential is more modest although still significant.

The relatively modest industry profitability is the most serious limitations to growth. Because of the competition from the State of Idaho and other producers, there is limited potential for prices to increase. In 1989, prices for rainbow trout dropped about 5% in the latter part of the year following to some extent the decline in prices witnessed for salmon and other species. In the longer term, prices for freshwater trout may continue to face demand pressures with the increasing supply of farmed salmon and other seafood products.

One possibility for a high growth scenario is for Canadian producers to succeed in increasing demand for freshwater trout. Under this scenario, Canadian producers will potentially produce as much as 5,200 MT of freshwater trout by 1995 and 7,300 MT by the year 2000.

Under this scenario, full-time equivalent employment in freshwater trout farming will be roughly equal to 425 full-time jobs by 1995 and 605 by the year 2000, based on a production of approximately 12 MT per full-time job. This production level was calculated based on statistics available for the Ontario industry as described below:

- A labour cost component of $1.00 per kilo of freshwater trout, based on cost data reported in 'Aquaculture in Ontario', a publication of the Ontario Ministry of Natural Resources.
- An average labour cost of $8.00 per hour and an average of 1,500 hours worked annually per full-time equivalent position.

High Growth Scenario - Marine Trout

The production of marine rainbow trout is also expected to increase in Atlantic Canada and B.C. One possibility is for Canadian production to increase to 5,000 MT by 1995 and 8,500 MT by the year 2000. This assumes that salmon farming will continue to be more popular than trout farming in B.C. and New Brunswick but that an increasing number of sites in Nova Scotia and land based systems will choose to rear rainbow trout over salmon.

Employment resulting from increased marine trout production under high growth assumptions is estimated at 185 full-time equivalent jobs by 1995 and 315 by the year 2000. This is based on an average production level of 27 MT per person year, which is comparable to the employment impact of salmon farming in B.C. and Eastern Canada. The growing of marine trout is assumed to be less

labour intensive on a per tonne basis than freshwater trout, primarily because freshwater trout farms are usually less capital intensive than salmon and marine trout farms.

The next paragraphs review the potential for trout farming by province.

High Growth Scenario - By Province

Ontario

The industry in Ontario has grown from producing about 100 MT of freshwater trout in 1970 to producing about 500 MT in 1984 and 1,925 MT in 1989. This growth in production translates to an increase of about 350 MT a year over the last five years dropping slightly between 1988 and 1989. Production had slower growth between 1981 and 1984, probably reflecting the high interest rates prevailing in that period and the poor economic climate.

One possibility under high growth assumptions is for Ontario production to increase to about 3,500 MT by 1995 and 4,500 MT by the year 2000. This represents an average annual production increase of some 320 MT per year to the year 1995 and 200 MT a year thereafter: an average increase of 9% a year to the year 1995 and 5% a year to 2000. This is lower than the 45% growth rate experienced since 1985. However, with the economy slowing down in Eastern Canada and interest rates having increased to current levels, production and investment growth can be expected to slowdown over the next few years.

The achievement of this production level will require the following:

- The Ontario industry succeeds in expanding domestic markets for fresh trout. The production increase of over 2,000 MT by the year 2000 represents an increase of about 300 grams of trout per capita, based on a population of eight million people in Ontario. This is a sizeable increase which will undoubtedly require extensive promotion to entice consumers in Ontario to increase their demand for fish and/or substitute trout for other fish. The challenge will be for producers to incur the costs associated with promotion and still continue to operate profitably.

- Economic conditions remain favourable to investments in the industry as the projected production increases will require the establishment of new sites. Trout farming in Ontario is often combined with other agricultural ventures such that the economic well-being of the agricultural community in Ontario could impact on the level of investment into trout farming. Also, increases in borrowing costs make financing an even more important constraint to growth. Financing is already difficult because the growth cycle of trout is between one and two years, longer than the average agricultural crop.

- The industry succeeds in maintaining labour, feed and other operating costs. The industry yields a relatively modest rate of return and it may not be able to bear any further increase in feed or other costs particularly with the recent increase in interest rates.

- The industry continues to control diseases successfully.

Quebec

The ability of Quebec to increase the production of freshwater trout will also depend on interest rates, overall economic conditions, the cost of production, and markets. Freshwater trout production for the food market in Quebec has remained stable in 1989 at about 260 MT after having increased from 130 MT in 1987 to about 250 MT in 1988. The provincial government has instituted a program to encourage trout production and the objective is to increase trout production to 1000 MT over the next five years.

One high growth scenario is that Quebec reaches this ambitious objective by 1995. Production will then be expected to grow by say 100 MT per year through to the year 2000, reaching an overall production level of 1,500 MT.

British Columbia

The B.C. industry can also be expected to grow over the next decade, albeit at a slower rate. Over the last ten years, the production of freshwater trout in B.C. has grown at a rate of 7% a year although production has remained stable in 1989. Under optimistic assumptions, the industry will grow at double that rate or about 15% a year. This translates to a production of some 300 MT by 1995 and about 600 MT by the year 2000.

This production level excludes any production of marine trout. With the recent growth in farmed salmon production in B.C., some of the farms and particularly the land based systems may decide to rear rainbow trout rather than salmon. For example, Hagensborg Marine Farms Inc., a land based farm with large circular concrete tanks located near Nanaimo, is currently rearing marine trout. Rainbow trout can be reared at a much lower cost than salmon and could become more attractive economically if salmon prices decline substantially in the near future. Production projections for marine trout will depend on the level of substitution between trout and salmon which is likely to take place in B.C. Nevertheless, provided that market conditions are favourable, one could expect production of marine trout to be about 3,000 MT by 1995 and some 5,000 MT by 2000 under high growth.

Atlantic Canada

Over the next ten years, the production of freshwater rainbow trout in Atlantic Canada will increase from about 150 MT in 1989 to 200 MT by 1995 and 300 MT by the year 2000.

Marine trout production is more likely to increase at a much faster rate than freshwater trout production because of the increasing interest in rearing marine trout and the unlimited supply of sea water. One

possibility is for the marine trout production to increase from about 300 MT in 1989 to 2,000 MT by 1995 and 3,500 MT by 2000.

Prairies and Territories

In the prairies and territories, trout farming is at a development stage. Accordingly, under an optimistic scenario, these provinces may produce about 200 MT of freshwater rainbow trout by 1995 and about 400 MT by the year 2000.

Low Growth Scenario - Freshwater Trout

One possibility is for industry to grow at relatively slower rate. Under this scenario, the Canadian production of freshwater trout may increase from about 2,500 MT in 1989 to about 3,400 MT by 1995 and 4,100 MT by the year 2000. This assumes the following:

- Interest rates remain at or near current levels and economic conditions worsens, such as to discourage new investments in the industry.
- The industry fails to develop new markets for freshwater rainbow trout. This may be partly as a result of increased competition from other species like salmon, mussels, oysters and other shellfish.
- Feed and other costs increase while prices remain at the same level because of increased competition from other fish and freshwater trout from the U.S. (particularly Idaho).

Under low growth assumptions, the industry will create about 270 full-time equivalent position by 1995 and about 340 by the year 2000. This is based on 12 MT per full-time equivalent position as was assumed in the high growth scenario.

Low Growth Scenario - Marine Trout

As regards the production of marine trout, production even under low growth assumptions is likely to be substantially higher than the 1989 level of about 600 MT. One possibility is that production will increase to about 2,000 MT by 1995, or about 200 MT per year and 3,500 MT by the year 2000. Under this scenario, the production of marine trout will be constrained primarily because of relatively unfavourable market conditions over the next five years.

Medium Growth Scenario

Under medium growth assumptions, the industry may produce 4,250 MT of freshwater trout and 3,500 MT of marine trout by 1995. By the year 2000, the industry may produce 5,700 MT of freshwater trout and 6,000 MT of marine trout. This represents a mid point between the low and the high growth scenario.

Under this scenario, employment in the freshwater and marine trout industry will be around 485 full-time equivalent positions by 1995 and 695 by the year 2000.

Conclusion

In conclusion, the farming of freshwater rainbow trout is not new to Canada and it continues to offer considerable potential for growth. A key challenge facing the freshwater trout industry will be the development of markets in an environment which will become increasingly competitive. The ability to maintain costs will also be a challenge as the freshwater trout farming sector is yielding only modest returns to the owner operators and investors. Throughout Canada, the farming of freshwater trout presents an alternate source of income to traditional farming and it is likely to continue to grow over the next decade. Production levels can be expected to be in the range 4,100 - 7,300 MT for freshwater trout by the year 2000, which will produce full-time equivalent employment in the range 340 - 605.

Contrary to the freshwater trout sector, the marine trout farming industry is new and will share much of the growth expected in the salmon farming sector over the next decade. By the year 2000 production of marine trout is likely to be in the range of 3,500 - 8,500 MT.

Chapter 7 - The Arctic Char Farming Industry

Historical Development

As a result of excess supply of certain cultured fish species, such as rainbow trout, there has been great interest in the commercial production of alternative species. Arctic char, in particular, has received considerable attention because:

- it is able to grow in water that is colder than that required for many other salmonid species;
- demand for Arctic char exceeds existing supply;
- Canadian consumers appear willing to pay premium prices for Arctic char.

The Department of Fisheries and Oceans first started cultivating Arctic char in 1978 at the Rockwood Experimental Hatchery in Manitoba. Years of research at this facility have resulted in the ability to provide the aquaculture industry with both seed stock and information concerning Arctic char culture. In 1985, the first private sector producers became involved in Arctic char culture. Although Arctic char cultivation is still in its early stages, there are now a number of operators developing broodstock populations and at least one commercial producer of Arctic char.

Arctic Char Production

Arctic char aquaculture is still in its very early stages, with only one supplier in Manitoba currently marketing Arctic char commercially on a regular basis. This supplier expects to produce approximately 7 tonnes in 1990. Several other operators are nearing commercial production, including one Yukon producer which expects to produce at least 24 tonnes of Arctic char in 1990.

There also appears to be very strong interest in Arctic char production throughout the industry. In 1988 the Department of Fisheries and Oceans supplied eggs to 23 producers to encourage cultivation of their own broodstock populations. Initial research suggests that a period of four years is required to establish an Arctic char broodstock, as the species appears to grow more slowly than trout, given existing culture technology.

Constraints Facing the Industry

Some of the factors which may constrain the cultivation of Arctic char are:

- A lack of broodstock has limited the rate at which operators are entering the industry. However, this problem is expected to rapidly dissipate over the next few years as government and private sector aquaculturists continue to build broodstock populations.

- Many Arctic char growers currently utilize rainbow trout culture techniques. As techniques for rearing Arctic char are refined and made specific to the population, improved culture practices can be expected.

- Size variability has been a significant problem. However, continued refinements to the breeding process will, over time, produce a species that has better culture characteristics and particularly, less variability in growth rate.

- Feed mixtures specific to the Arctic char have yet to be developed. It is expected that commercially prepared Arctic char diets may enhance feed conversion rates as well as yield more commercially acceptable flesh colours. Red-fleshed char commands a higher retail price than lighter colours.

- Arctic char has a longer grow out period than certain other salmonoids such as rainbow trout. This increases production costs and restricts the industry's ability to respond to changes in supply, demand and technology.

- Arctic char does not have high name recognition in the large U.S. marketplace, which may limit its acceptance in the U.S.

Strengths of the Industry

There is very strong interest in Arctic char culture across Canada. This is due to the following factors:

- Arctic char is considered to be an excellent food fish. It has high consumer appeal, and as such commands a premium price relative to other fish. Wholesale prices for Arctic char range from $6.00 to $9.00 per kilogram for a 1 to 2 kilogram fish.

- The relative ease of culture makes the species attractive to aquaculturists. Producers currently rearing trout are particularly interested in rearing Arctic char because of the similarity of culture techniques combined with higher wholesale prices.

- Arctic char grows well in colder water than that required by rainbow trout.

- Market conditions for Arctic char are strong: demand is high, competition is limited and current supply levels fall a long way below market capacity.

Outlook for the Industry

Within the next few years, the supply of Arctic char in Canada is expected to increase significantly as a result of increasing aquaculture production. Because the industry is still at an early stage of development it is extremely difficult to establish meaningful growth projections. However, based on current production levels and existing levels of interest, it is reasonable to expect substantial increases

in the supply of Arctic char by 1995 and beyond to the year 2000. Canadian production of farmed Arctic char in 1990 is expected to be between 7 and 10 metric tonnes and production in subsequent years should increase. It is possible, however, that as culture operations expand and the supply of Arctic char increases, prices could decline as has been the case with trout.

Conclusion

The outlook for Arctic char as a cultivated species is promising. The high price of Arctic char combined with the relative ease of rearing, make it a very attractive alternative to other species, especially rainbow trout. However, the industry will have to overcome such problems as a shortage of broodstock populations, and a marked variation in the size of cultured fish.

Chapter 8 - Scallop Farming

Historical Development

Research and development of scallop aquaculture began in Canada in the late 1960's, but initial culture attempts were largely unsuccessful. A 1980 Department of Fisheries and Oceans study concluded that scallop aquaculture, using suspended culture techniques (lantern nets), was not economically feasible. However, in the early 1980's, renewed interest in scallop culture developed as a result of the depletion of wild stocks and further studies of scallop cultivation which demonstrated the viability of ear-hanging culture techniques. At least twenty research facilities and commercial operators are now involved in scallop aquaculture. At present, there is no significant commercial production of scallops in Canada, although a small volume of bay scallops has been produced in the Maritime provinces.

Production

Scallops are cultivated in many countries throughout the world, but Japan is by far the largest producer. Japan has been cultivating scallops for at least twenty years. Estimates of annual production for 1989 vary between 100,000 MT (whole animal) and 200,000 metric tonnes (live scallop). In Canada, scallop aquaculture is still in its early stages. In 1989, 20 metric tonnes or 0.02% of total scallops harvested in Canada were cultured. The value of the harvest has been estimated at $210,000.

Three types of scallops are currently being cultured in Canada: sea scallops, bay scallops and Japanese scallops. There are currently two commercial scallop hatcheries operating in Canada, one in Nova Scotia (bay scallops) and the other in British Columbia (Japanese scallops). The B.C. hatchery has received at least fifty applications for scallop farming on a joint-venture basis. There are a number of research hatcheries in Canada which do not operate on a commercial basis. Though sea scallops are not produced commercially at the moment, substantial seed supplies have been developed at facilities in Newfoundland and test marketing is planned for this year.

Constraints Facing the Industry

Some of the constraints facing the industry are:

- The economic viability of scallop culture has not been established because of the early stage of industry development. There is some evidence that existing grow-out methods may not be economical - particularly those relating to sea scallops and Japanese scallops.
- Cost-effective, predictable seed supplies for bay scallops have not been developed: technical problems still hamper production of seed and private and government hatcheries have not yet produced adequate quantities of seed.
- Bay scallops cannot survive Canadian winters and must be harvested after only one season of growth. Consequently, bay scallops are smaller than scallops grown in warmer climates.
- There are limited genetic strains in the current Maritime bay scallop population. Thus, in order to improve culture quality, new genetic strains may have to be introduced (a process which has already begun). It is possible that this could encourage large-scale bay scallop aquaculture.
- Cultured scallops have to compete with both wild stocks and a sizeable volume of imports.
- A parasite has been detected in certain bay scallops; this could delay or restrict bay scallop aquaculture, (the parasite is thought to be a "Perkinsus sp. like" organism).
- It appears that marketing research has been undertaken to-date by scallop producers on sea scallop "meats", although test marketing is still being undertaken by some producers. However, additional market research is needed for "Roe-on" sea scallops.

Strengths of the Industry

- Scallops have a reputation as a relatively high-priced, gourmet food item: prices are higher than for certain other shell fish.
- Bay scallops are harvested in less than one year. This short grow-out phase could lead to increased farm production and greater industry profitability.
- Scallops have been successfully cultured on a commercial basis in other countries. A precedent therefore exists and initial start-up problems could be minimized.
- Commercial wild scallop supply fluctuates annually and seasonally. Scallop growers may be able to capitalize on these variations.
- Geographic regions favourable to scallop cultivation have been identified in British Columbia, Newfoundland, New Brunswick, Quebec, Nova Scotia, and P.E.I. Different species will be appropriate in each region.
- The cultivation of scallops will not conflict with that of oysters or mussels as scallops are cultivated at greater depths than other species of shellfish.

Outlook for the Industry

Scallop aquaculture is an emerging industry; commercial production remains limited, and research and development is ongoing. Consequently, it is difficult to develop meaningful growth forecasts. To-date, the industry has been successful in overcoming a number of technical challenges associated with scallop aquaculture and test marketing is about to be launched by some producers. In some cases, commercial production looks probable within the next few years. But some problems remain to be solved and it is likely that much of the industry will remain in a research and development phase until 1995. Given adequate time and funding, the industry as a whole should be able to overcome the impediments which currently limit its development and become commercially viable by the year 2000.

Conclusion

There are currently three species of scallops being cultured in Canada, the bay scallop, the Japanese scallop and the sea scallop. Significant commercial production of these species is still a number of years away. There are several challenges which still face the industry, and its ability to overcome these obstacles will determine its future. However, a number of technical challenges have already been overcome and the future of the scallop industry in Canada looks promising.

Source: Cyr Couturier. "Scallop aquaculture in Canada: fact or fiction?", World Aquaculture Magazine (June 1990) (vol. 21 (2): 54-62.

Summary and Conclusions

In conclusion, the aquaculture industry in Canada is young and dynamic and the potential for growth is substantial. This chapter summarizes the production and employment projections of the major sectors of the industry and presents the combined employment impacts projected for the industry. A summary of the production and employment projections for salmon, oyster, mussels, marine trout and freshwater trout are presented in Table 26. Estimates for Arctic char and scallops have been omitted from these figures because of the difficulty of estabishing production and employment projections for these sectors.

TABLE 25

Summary of Production and Employment Projections

	Production (000's metric tonnes)			Employment (full-time equivalent positions)		
	1989	**1995**	**2000**	**1989**	**1995**	**2000**
Salmon						
B.C.	12.4	20-30	30-60	800	950-1,000	1,050-1,800
Atlantic Canada	4.3	7.6-12	9-15.5	300	315- 540	315- 600
Total	16.7	27.6-42	39-75.5	1,100	1,265-1,540	1,365-2,400
Oysters						
B.C.	3.9	5-7	6-12	225	250-350	300- 600
Atlantic Canada	2.4	3-5	4-7	120	150-250	200- 350
Total	6.3	8-12	10-19	345	400-600	500- 950
Mussels						
B.C.	-	-	0-0.2	-	-	0- 20
Atlantic Canada	3.0	3.5-5	4.3-7	200	230-330	280-450
Total	3.0	3.5-5	4.3-7.2	200	230-330	280-470

TABLE 25

Summary of Production and Employment Projections (continued)

	Production (000's metric tonnes)			Employment (full-time equivalent positions)		
	1989	1995	2000	1989	1995	2000
Marine Trout						
B.C.	0.3	1-3	2-5	10	40-110	75-185
Atlantic Canada	0.3	1-2	1.5-3.5	20	40- 75	55-130
Total	0.6	2-5	3.5-8.5	30	80-185	130-315
Freshwater Trout						
B.C.	0.125*	0.15-0.3	0.2-0.6	10	10- 25	15- 50
Atlantic Canada	0.150*	0.15-0.2	0.2-0.3	10	10- 15	15- 25
Ontario	1.925	2.5 -3.5	3 -4.5	160	200-290	250-375
Quebec	0.260	0.5 -1	0.6-1.5	20	40- 80	50-125
Prairies & Territories	0.100	0.1 -0.2	0.1-0.4	10	10- 15	10- 30
Total	2.560	3.4 -5.2	4.1-7.3	210	270-425	340-605
Combined Impacts						
B.C.				1,045	1,250-1,485	1,440-2,655
Atlantic Canada/Quebec				670	785-1,290	915-1,680
Ontario				160	200- 290	250- 375
Prairies & Territories				10	10- 15	10- 30
Total				1,885	2,245-3,080	2,615-4,740

* estimated based on 1988.

The Salmon Farming Industry in B.C.

- Salmon farming is gaining importance in B.C. with production in 1989 being estimated at 12,400 MT up from 6,590 MT in 1988. Although there have been a number of receiverships occurring in B.C. in 1989/90, rationalization was expected after a period of rapid growth. While other mergers and acquisitions may occur in the short term, the number of operating sites and production is expected to grow, albeit at a slower rate. Over the next five years, production is

likely to range between 20,000 MT and 30,000 MT by 1995 and between 30,000 and 60,000 by the year 2000. The B.C. production is unlikely to match the 1989 Norwegian production of 117,000 MT by the year 2000 because of increasing competition from other countries and marketing constraints.

The Salmon Farming Industry in Eastern Canada

- Salmon farming is also gaining in importance in Eastern Canada. In that region, salmon farming is concentrated in the Bay of Fundy in New Brunswick but the industry is gaining in importance in Nova Scotia and to a lesser extent in Quebec and P.E.I. through the use of land based systems. Salmon farming in Newfoundland is at an experimental stage. Farmed salmon production in Eastern Canada in 1989 is estimated at 4,600 MT. The Eastern provinces are projected to produce between 7,600 and 12,000 MT by 1995 and 9,000 MT and 15,500 MT by the year 2000.

- These production estimates assume that the current technology of net pens operating in sea water will continue to be the most prevalent technology used in salmon farming. Technological changes and the widespread adoption of land-based and other systems could result in even higher projected growth. Land-based systems are technically feasible but their commercial viability has yet to be established.

The Oyster Industry in B.C.

- 1989 oyster production in B.C. is estimated at 3,700 MT. The industry is projected to produce between 5,000 MT and 7,000 MT by 1995 and between 6,000 and 12,000 MT by the year 2000. Major constraints which will restrict the growth of the industry include the cost and availability of seed from hatcheries, financing and markets.

The Oyster Industry in Eastern Canada

- 1989 oyster production in Eastern Canada was 2,422 MT and because of water temperatures and other conditions was restricted to New Brunswick, Nova Scotia and P.E.I. Oyster production in Eastern Canada is projected to increase to between 3,000 MT and 5,000 MT by 1995 and between 4,000 MT and 7,000 MT by the year 2000.

The Blue Mussel Industry

- Mussel production in Canada is expected to exceed 3,000 MT in 1989 with P.E.I. accounting for about 90% of the overall production (based on data published by the Department of Fisheries and Oceans). Industry production in Eastern Canada is expected to range between 3,500 MT and 5,000 MT by 1995 and between 4,300 MT and 7,000 MT by the year 2000.

- The industry in B.C. is at an experimental stage as it is experiencing severe duck predation, unexplained pre-harvest mortalities and other problems. Depending on the ability of the industry to deal with these problems on a cost efficient basis, the mussel industry in B.C. will either remain

at an infancy stage and continue to produce less than 5 MT throughout the decade or it will develop as a viable industry and potentially achieve a production of 200 MT by the year 2000.

Trout Farming

- Freshwater trout production in Canada for 1989 was 2,500 MT with about 80% being produced from Ontario. The industry is relatively mature and it is expected to produce between 3,400 MT and 5,200 MT of freshwater trout by 1995 and between 4,100 MT and 7,300 MT by the year 2000.

- While trout farming in Canada is primarily carried out in fresh water, the interest for marine culture has been growing, primarily in Nova Scotia. In 1989 marine rainbow trout production is estimated at 600 MT with 200 MT from Nova Scotia, 100 MT from other Atlantic provinces and 300 MT from B.C. Production of marine trout is likely to range between 3,500 MT and 8,500 MT by the year 2000 rising from 2,000-5,000 in 1995 following to some degree the growth experienced in salmon farming.

The Arctic Char Farming Industry

- 1989 production lay at approximately 7 MT. Production can be expected to increase to some 30 MT in 1990 when a second operator moves into the commercial market.

- Interest in the char industry, the high price of the fish on the market and relative ease of cultivation suggest that growth in the future could be rapid. At least 23 operators are involved in research and development with the species, supplied with broodstock by the Department of Fisheries and Oceans.

- It has been impossible to define full-time equivalent positions relating to char and to establish growth projections because the industry is still in an early stage of development.

Scallop Farming

- Of the three species of scallop cultivated in Canada (bay, japanese and sea) only bay scallops are commercially produced. In 1989, 20 MT of bay scallops were produced, valued at $210,000.

- There is significant interest in the scallop industry and research and development are ongoing. A number of the technical problems facing the industry have been solved, and though several still remain, the prospects for commercial development are optimistic.

- Through it is difficult to assess current employment and to project expected production and employment levels to the year 2000 it is probable the commercial viability will have been established by 2000 and that both production and empioyment will increase dramatically.

Combined Employment Impacts

The analysis of employment in this report is based upon estimates of full-time equivalent positions calculated according to the methodology described in the executive summary and each respective chapter. This approach has excluded significant employment in hatcheries, processing plants and equipment and seed supply companies. Broader estimates of employment would show figures two to three times higher than those presented here.

- In 1989, the salmon, oyster, mussel and trout farming sectors generated 1,885 direct full time equivalent positions, excluding employment in hatcheries and industries supplying the industry. About 55% of this employment is in British Columbia, 36% is in Atlantic Canada and Quebec, 8% is in Ontario and the remaining 1% is in the rest of Canada.

- Between 1988 and 1989, employment increased by about 140 full-time equivalent positions in Eastern Canada but remained about the same in B.C.:
  - employment increased by some 125 full-time equivalent positions in Eastern Canada following an increased in salmon, oyster, mussel and marine trout production as well as an increase in the number of salmon farms;
  - employment increased by about 10 full-time equivalent positions in Ontario reflecting higher fresh water trout production; and
  - employment remained about the same in British Columbia at about 1,000 full-time equivalent positions with the increase of 200 jobs from that reported last year primarily reflecting changes in methodololgy.

- Employment in the salmon, oyster, mussel and trout farming sectors is expected to range between 2,245 and 3,080 full-time equivalent positions by 1995 and between 2,615 and 4,740 by the year 2000.

** ** **

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WORLDWIDE PRODUCTION OF FARMED SALMON

WORLDWIDE PRODUCTION OF FARMED SALMON, 1981-1989
(metric tonnes)

A. FARMED ATLANTIC SALMON

	1981	1982	1983	1984	1985	1986	1987	1988	1989
Norway	8,910	10,266	17,016	22,300	28,655	45,675	47,417	80,300	117,000
Scotland	1,000	2,100	2,536	3,912	6,921	10,300	12,600	17,600	28,500
Ireland	35	103	257	385	650	650	2,500	4,200	6,200
Farce Islands	100	130	160	300	450	600	2,500	3,400	6,000*
Iceland	20	30	50	70	90	100	1,000	1,300	1,800*
Other	60	80	100	75	300	390	400	1,990	3,220*
Eastern Canada	28	48	126	163	188	297	1,300	3,300	4,600
Total	10,153	12,757	20,245	27,205	37,254	58,012	67,717	112,090	167,320

B. FARMED COHO AND CHINOOK

	1981	1982	1983	1984	1985	1986	1987	1988	1989
B.C.	176	273	128	107	120	397	1,362	6,590	12,400
Chile	60	80	100	270	870	1,000	1,600	3,100	6,680
Western U.S.	450	680	900	1,176	1,257	1,507	2,000	1,900	4,000
Japan	1,150	2,122	2,760	5,049	6,430	7,220	12,000	14,060	17,100
Other	60	80	80	90	100	180	200	200	200*
New Zealand	2	5	10	20	500	500	1,500	1,650	2,000*
Total	1,898	3,240	3,978	6,712	9,277	10,804	18,500	27,500	42,380

* Preliminary estimates

Source:

1988 Data: Fish Farmer Magazine, Jan./Feb., 1990, A.A.C. Bulletin, 89-4.

1988 Data: World Aquaculture Magazine, Vol. 20(2) and 20(3).

1981-1986 Data: Worldwide Farmed Salmon Production Forecasts, report prepared for the Department of Fisheries and Oceans, Canada, by the D.P.A. Group Inc., March 1988.

1989 Data: Fish Farming International, Jan./Feb., 1990.
D.P.A. Group
For Canada, discussions with governments and industry.